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AN INVENTORY OF ALBERTA'S PASTURE RESOURCES AND ESTIMATED POTENTIAL BEEF
PRODUCTION FROM THE IMPROVEMENT OF PRIVATELY OWNED LAND

by



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The undersigned certify that they have read and recommend to the Faculty of Graduate Studies for Acceptance, a thesis entitled "An Inventory of Alberta's Pasture Resources and Estimated Potential Beef Production From the Improvement of Privately Owned Land," submitted by Melville L. McMillan, in partial fulfillment of the requirements for the degree of Master of Science.

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ABSTRACT

This investigation of Alberta pasture resources, current and potential, was based upon information secured from 1,610 randomly selected farms throughout the province. Additional data was obtained from smaller groups of farmers who had improved pasture. The analysis was conducted on both a provincial and regional basis.

An inventory of pastureland reported the acreage of various types of pastures and the production from each. Native pastureland, much of it unimproved, dominated both acreage and production.

The respondents estimates of the potential to improve present pastures and develop new pastureland were recorded. In addition to other factors which influenced the decision to improve, the cost of improvement practices were investigated.

A linear programming model utilized survey data to predict possible pasture improvement and expansion of cattle numbers under various price, cost, and production assumptions. With prices moderately above the 20 year average and improved management, there appeared to exist a strong likelihood that cattle numbers in Alberta could increase substantially.

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CHAPTER I

INTRODUCTION

The Situation

By 1980 Canada will require an additional 11 million acres of improved grassland if domestic beef supplies are to meet the growing demand.¹ This addition represents an increase in forage production of 34.7 percent above the 1961 level.

The estimated number of beef cattle required in 1980--allowing for an expanded population, increased per capita consumption and net exports--is 57 percent above 1964 levels even after considering heavier carcass weights and advances in the breeding and feeding of cattle (Table 1). The largest increase is expected in the numbers of young stock. Cow numbers are expected to increase 51.9 percent. The increased use of artificial breeding will eliminate the need for a greater number of bulls.

To meet forage requirements of the current cattle population, Canadian farmers utilized 42.1 million acres of unimproved pasture and 13.8 million acres of improved forage. This acreage was considered equivalent to 31.7 million acres of improved grassland when 5.5 acres of unimproved range are equivalent to one acre of improved grassland.

If no advances in grassland management are forthcoming during the period 1961-1980, the equivalent of 15.8 million acres of improved forage land must be put into production by 1980 in order to meet the

¹ L. E. Drayton et al, "The Demand for Beef in 1980 and Related Land Requirement," Economic Annalist, XXXIV (August, 1964).

TABLE 1

CANADIAN CATTLE NUMBERS IN 1958-62 AND PREDICTED NUMBERS IN 1980

Class	1958-62 (Million)	Predicted for 1980 (Million)	Percentage Increase
Cows	5.2	7.9	51.9
Bulls	.3	.3	0
Young Stock	6.0	9.8	63.3
Total	11.5	18.0	56.5

Source: L. E. Drayton, "Demand for Beef in 1980 and Related Land Requirements," Economic Annalist XXXIV (Aug. 1964).

forage needs of the projected cattle population. If, however, improved techniques are employed to increase the grazing potential of unimproved rangeland 20 percent and improved grassland 10 percent, estimated land requirements would be reduced to the equivalent of 11 million acres of improved grassland.

Approximately 75 percent of Canada's cow herds are in the Prairie Provinces and of these one-half are in Alberta. Eighty percent of Alberta farms reported cattle on hand January 1, 1965. A majority of the herds were less than 50 animals, especially in the northern half of the province (Appendix A, Table 39). Not only has there been an absolute increase in beef cattle numbers in this province (Table 2), but also the relative importance of beef production as a source of farm income has risen from less than 10 percent in 1930 to over 30 percent in 1960 (Table 3). Of farms with cattle, less than one fourth had cattle sales exceeding \$5,000.00 (Appendix A, Table 40). In addition to Alberta's

prominent position in cattle production, the province has a large grazing potential in underutilized grassland and land not yet devoted to agriculture.

TABLE 2

BEEF COW NUMBERS IN ALBERTA IN SELECTED YEARS

Year	Number
1951	420,427 ^a
1956	733,930 ^a
1961	890,226 ^a
1965	1,028,000 ^b

^a Canada, Dominion Bureau of Statistics, Census of Canada - General Review, Crops and Livestock, 1961.

^b Alberta, Alberta Department of Agriculture, Agricultural Statistics for Alberta, 1965.

TABLE 3

CATTLE SALES AS A PERCENTAGE OF FARM INCOME FOR SELECTED YEARS, ALBERTA

Year	Percent
1930	6.5
1940	9.6
1950	23.7
1960	33.4

Source: Canada, Dominion Bureau of Statistics, Census of Canada, Bulletin 5.3 - 3, 1961.

Canada, Dominion Bureau of Statistics, The Canada Yearbook, 1930, 1940 and 1950.

The Problem - Implications of a Rising Demand for Beef

Canada is experiencing a strong demand for beef which is expected to continue, thus necessitating the utilization of additional agricultural resources to meet higher levels of consumption. Agricultural resources of Alberta could contribute significantly to meeting these future requirements.

The problem with which this research dealt was an appraisal of the potential for beef production within the province of Alberta that might reasonably be developed on privately owned lands within the near future under current cost and price conditions.

For privately owned grazing lands this problem has two important aspects (a) how expansion would occur in each of several important beef producing regions in Alberta and (b) what range of improvement practices would be most efficient in each region.

Objectives of the Study

Three basic objectives provided a framework for analysis of the problems posed. The first objective was to make an inventory of the provincial pastureland. This inventory included data on the acreage and carrying capacities of pastures throughout Alberta by pasture type and tenure classes.

The second objective was to estimate the potential grazing which could be obtained by the improvement of currently used pasture and the development of additional pastureland. Such estimates were made solely for privately owned land. To achieve this objective, the collection of estimates and investigation of costs associated with improvement and development of pastureland was necessary. Information concerning the expected pro-

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ductive potential of new or improved grazing lands was also required.

The third objective was to determine a feasible pattern for increased beef production. A linear programming model was used to solve this interregional competition problem. The model predicted the regional increase in beef production and the resource combinations required for that additional output.

Methodology

The Sample

A random sample of Alberta farms was drawn by the Dominion Bureau of Statistics from their current list of farm operators.¹ This sample based upon the 1961 census was supplemented by information secured by means of mail interviews. Field organization was by census enumeration area, essentially in the same order as the census enumerator completed field work. The sample was drawn in clusters of four farms.

The population was sampled at two different ratios. The southern areas of the province, including census divisions one to six, nine, and Improvement Districts 65 and 68 of census division eight, were sampled at a rate of one in thirty. The remainder of the province--census division seven, and census divisions ten to fifteen--was sampled at a rate of one in fifty. The resulting sample included 392 clusters of four farms each. The one in thirty ratio was used in the southern region where grassland plays a dominant role in agriculture, and the number of farms was small relative to the land area.

¹ The cooperation and assistance given at this stage of the study by Wayne A. Fuller, Professor of Statistics, Iowa State University, Ames, Iowa and J. Graham, formerly of the Dominion Bureau of Statistics and R. W. Ellis, currently on the Bureau of Statistics Staff (Assistant Director, Agriculture), was much appreciated.

The sample from the census list provided 1568 of the 1610 names which finally comprised the sample. The remaining 42 names were selected from a list of active homesteads acquired during the period July 1, 1961, to July 1, 1963. This list was obtained from the Director of Lands. The sample selected from the list was clustered by address at the same sampling rate used in the census district where it was located. The majority of those selected came from census division 15.

The Questionnaire

The questionnaire was designed to secure information concerning the use of pastureland, the type of pasture, and the carrying capacity. Estimates sought were the potential acreage which could be developed for pastureland and the acreage currently used as pasture which could be made more productive by the use of pasture improvement practices. Farmers' opinions relevant to pasture use and pasture improvement were recorded. Finally a substantial amount of general information about the farm, its operation, management, and operator, was secured.

Response

During the summer of 1965 interviews were obtained from 1361 of the 1610 names on the sample list. This was a return of 85.2 percent. Only 3.6 percent of 58 individuals refused to cooperate. Seventy-nine farms in the sample were rendered ineligible due to land transactions which had transferred ownership since the 1961 census. The sample contained names of partners for which only one questionnaire was completed even though it represented two or more farms on the census list. Also a few farmers in the sample were operating more than one of the farms drawn in the sample. These two reasons caused a reduction of 34 questionnaires in the sample but

held the land area represented constant. Sixty-eight farmers were not interviewed due to a variety of reasons. Twenty-four respondents were ineligible since their sales of agricultural products the previous year failed to exceed \$50.00. Two men appeared on the sample twice and the remainder were not interviewed due to language barriers, illness, recent death, and the inability to locate.

Cost Questionnaire

The individuals interviewed provided names of farmers they knew who had undertaken pasture improvement. This list was then supplemented by names suggested by district agriculturists. A list of 512 names was compiled, representing all sectors of the province. These men were contacted by mail and asked to complete and return a questionnaire concerned primarily with the costs they had experienced while carrying out various pasture improvement programs.

Following an initial request and one reminder, 367 replies were received--a response of 69.7 percent. Usable information was compiled in 301 questionnaires. The data derived from this response was used to supplement cost data from the larger sample.

Analysis

With the aid of members of the Department of Lands and Forests and the Farm Economics Branch, eight grazing regions were established as given in Table 4, Figure 1, and also in Appendix A. Where possible, regional boundaries were drawn along census division lines to permit the use of census and other official data for additional information and comparison.



FIGURE I
Grazing Regions of Alberta

TABLE 4

AN OUTLINE OF THE GRAZING REGIONS AND AVERAGE FARM SIZE IN EACH¹

Region	Census Districts Included	Soil Zone	Average Farm Acreage	Number of Cattle per Farm	Sales per Farm
I	C.D. 1 & 4 (less farms with irrigated pasture)	Brown	2,262	74	\$ 9,903
II	C.D. 2 (less farms with irrigated pasture)	Brown and Dark Brown	974	50	13,246
III	All farms with irrigated pasture (all in C.D. 1, 2, 3 and 5)		1,093	118	13,042
IV	C.D. 3 (less farms with irrigated pasture) and C.D. 6	Thin Black	953	93	15,718
V	C.D. 5 (less farms with irrigated pasture) and C.D. 7	Dark Brown and Thin Black	1,032	56	14,063
VI	C.D. 8 (less ID 65 & 68), C.D. 10 and C.D. 11	Black with some Thin Black and Grey Wooded	442	39	7,165
VII	C.D. 12, 13, 14 and ID 65 and 68 of C.D. 8	Grey Wooded and Dark Grey Wooded	471	32	4,348
VIII	C.D. 15	Grey Wooded	626	16	4,845

¹ All tables whose source is not otherwise indicated include data based upon the survey of 1371 farms throughout the province.

Regional grouping provided internally homogeneous areas, simplified the analysis, and expanded the base upon which statistics were calculated to more than a single census division. Regional grouping provided larger areas for estimation thus increasing the reliability of the data produced.

Estimation

Expansion factors were calculated to make estimates from the data gathered in the survey. The values of expansion factors for each census division exceeded the reciprocal of the sampling rate for three reasons. First, the survey took one interview for each business unit regardless of the number of operators (i.e., partnerships) rather than following the census definition of one farm, one operator.

As a result, the survey indicated that there were 97.3 farm business units for each 100 census farms. Secondly, new homesteads augmented farm numbers. Finally, there were fewer usable questionnaires than farms on the sample.

When the expansion factor was used to estimate the number of farms in each census district, the estimates were consistently below 1961 census figures. The estimated number of farms in the province in 1965 was 65,674 when the farm was considered as a business entity. If the census practice of one farm, one operator were used, the estimated number of farms would increase to 67,496. This value compares with the 1961 census figure of 73,212 farms and the 1966 figure of 69,411 farms. The decline of census farm numbers between 1961 and 1966 was 5.2 percent. The survey estimate of the provincial total farm acreage was only 1.25 percent larger than the 1961 census total.

The expansion factor for each region was calculated by taking a weighted average of the expansion factors of the relevant census divisions. Weights used were the number of farms in each census division. Comparison of the estimated and census regional farm acreage values gave moderate variation. Only in Region VIII (C.D. 15) was the difference greater than 10 percent. This estimate was greater than the census value partly because additional homesteads had been established since the 1961 census.

CHAPTER II

ON INVENTORY OF ALBERTA PASTURELAND

One objective of this study was to estimate the acreages and carrying capacities of the various types of pastureland currently utilized in Alberta. Such data was necessary to cope with questions of the potential for improvement and benefits which might be derived from the use of various improvement practices. Such estimates were unavailable elsewhere and should prove useful to administrators of public grazing lands.

The grazing lands were reviewed with respect to the acreage of the component types of pasture and to the relative importance of each type as a contributor to forage production. Land tenure and its influence upon the intensity of grazing was analyzed. A brief note comparing lease terms and costs on public and private land concludes this chapter.

Types of Pastureland

The pastureland of Alberta was divided into six classifications--unimproved native, improved native, tame, irrigated native pasture, irrigated tame pasture, and crop residue or aftermath. Unimproved and improved native pastures differ in the sense that the improved native has received physical or chemical treatment to modify the composition or increase the production of the sward. Crop residue or aftermath grazing is that obtained from the utilization of hay and crop stubble. Grazing was not intended as the prime use of such land.

Pasture Acreage and Production--Provincial Analysis¹

It was estimated that there were 19.3 million acres of land used solely for pasture in Alberta. Another 6.3 million acres of crop residue was grazed, one quarter of the total acreage pastured. Of the land which was solely pasture, unimproved grassland constituted almost 85 percent. Improved native grassland contributed 6.9 percent and tame pasture eight percent. Irrigated pasture was primarily tame grass and made up less than one percent of the total acreage (Table 5). Essentially all of Alberta's pastureland is permanent pasture--less than three percent is part of a crop rotation.

Considering the contribution of each type of pasture toward the total forage production grazed, crop residue provided 12.4 percent of the total forage production, making it an important source of pasture (Table 6). Unimproved native pasture contributed 60.6 percent and improved native pasture 6.4 percent of the forage on the farms studied. From six percent of the acreage grazed, tame pasture produced over 18 percent of the forage. Irrigated pastures provided about two percent of total production.

A potential for improvement was evident if the "Crop Residue" classification was deleted and a comparison made of the relative acreages and productivity of land used only as pasture. Four types of improved pastures contributed as much or more to forage production as they did to pasture acreage. Unimproved native pasture, however, provided 84.5 percent of the pastureland but only 69.1 percent of the animal unit months grazed.

¹ All estimates of acreage and production exclude the acreage and production of community pastures, grazing reserves and other public land used jointly for pasture by more than one operator and paid for on a per head basis. Estimates of the data excluded are given in Appendix A.

TABLE 5

PASTURE ACREAGE BY TYPE - ALBERTA 1965

Type of Pasture	Total Acres	Distribution Crop Residue Included	Distribution Crop Residue Excluded
	(1,000's)	(percent)	(percent)
Unimproved Native	16,345.0	67.3	84.5
Improved Native	1,330.0	5.2	6.9
Tame	1,540.0	6.0	8.0
Irrigated Tame	94.2	0.3	0.5
Total Grassland Pasture	19,333.5	--	100.0
Crop Residue	6,334.0	24.7	--
Total Including Crop	25,677.5	100.0	--

TABLE 6

ANIMAL UNIT MONTHS OF GRAZING PROVIDED BY TYPE OF PASTURE

Type of Pasture	Total Animal Unit Months	Distribution Crop Residue Included	Distribution Crop Residue Excluded
	(1,000's)	(percent)	(percent)
Unimproved Native	8,112.0	60.6	69.1
Improved Native	862.2	6.4	7.3
Tame	2,471.0	18.4	21.1
Irrigated Tame	284.0	2.1	2.4
Total Pasture AUM	11,738.7	--	100.0
Crop Residue	1,662.0	12.4	--
Total AUM Including Crop Residue	13,400.7	100.0	--

Pasture Acreage and Production--Regional Analysis

Acreage

Unimproved native pasture was a large part of the pasture in all regions (Table 7). Native grass unimproved and improved represents approximately 90 percent of the pasture acreage in Regions I, II, and III. Tame grassland was most important in Regions VI, and VII. Irrigated pastures (by definition included in Region III) both tame and native account for slightly less than 120,000 acres in the province. Crop residue grazing on 6.34 million acres is an important source of fall grazing for 60 to 90 days each year.

Table 7 provides important interregional comparisons by reading down each column. Intraregional examination of pasture types is given by reading Table 7 horizontally. This table provides a major source of basic data in the physical inventory of Alberta's grazing lands.

Production

All types of pasture produced 13.4 million animal unit months (AUM) of grazing (Table 8). Over 73 percent of the AUM were produced in Regions IV, V, VI, and VII. Region VI produced 26 percent of all the AUM of grazing in Alberta. Table 8 is an important basic data component of the inventory of grazing lands in Alberta. Arrangement of this table parallels Table 7 in that reading vertical columns provides interregional comparisons of the six types of pasture and reading across the rows gives the intraregional source of AUM by type of pasture.

The row in Table 8 entitled provincial summary is a ranking of the importance of the six types of pasture. Unimproved native pasture produced three fifths of all AUM, tame pasture is in second place at 18.4

TABLE 7

REGIONAL DISTRIBUTION OF PASTURE ACREAGE BY TYPE OF PASTURE

Region	Unimproved		Improved		Tame		Irrigated		Irrigated		Crop		Total	
	Acres	%	Native	Acres	%	Acres	%	Tame	Acres	%	Native	Acres	Residue	%
(thousands of acres)														
I	4,937	79.5	619	10.0	86	1.4						570	9.1	6,212 100.0
II	934	87.4	29	2.7	71	6.6						35	3.3	1,069 100.0
III	1,194	86.4	1	.1	16	1.1		94.2	6.8		24.3	1.8	52	3.8 1,381 5,100.0
IV	2,671	73.5	116	3.2	227	6.2						623	17.1	3,637 100.0
V	2,379	63.6	201	5.4	210	5.6						949	25.4	3,739 100.0
VI	1,781	37.3	178	3.7	506	10.6						2,315	48.4	4,780 100.0
VII	1,435	48.5	168	5.7	318	10.7						1,038	35.1	2,959 100.0
VIII	1,041	53.4	18	.9	106	5.6						762	40.1	1,900 100.0
Pro- vince	16,345		1,330		1,540		94.2		24.3			6,344		25,677.5

TABLE 8

REGIONAL DISTRIBUTION OF ANIMAL UNIT MONTHS OF GRAZING BY PASTURE TYPE

Region	Unimproved		Improved		Tame		Irrigated		Irrigated		Crop		Total	
	AUM	%	AUM	%	AUM	%	AUM	%	AUM	%	AUM	%	AUM	%
(thousands of AUM)														
I	1,316	81.5	177	11.0	45	2.8					76	4.7	1,614	100.0
II	446	68.9	44	6.8	137	21.2					20	3.1	647	100.0
III	382	53.1	.2	.1	22	3.1	284	39.5	9.5	1.3	21	2.9	718	7,100.0
IV	1,902	74.7	132	5.2	307	12.0					207	8.1	2,548	100.0
V	1,289	66.6	129	6.7	244	12.6					274	14.1	1,936	100.0
VI	1,631	46.8	201	5.8	1,019	29.2					635	18.2	3,486	100.0
VII	772	42.3	165	9.1	560	30.7					326	17.9	1,823	100.0
VIII	374	59.6	14	2.2	137	21.8					103	16.4	628	100.0
Provincial Summary ^a	8,112	60.5	862.2	6.4	2,471	18.5	284	2.1	9.5	.1	1,662	12.4	13,400.7	100.0

^a The percentage values given represent the AUM contributions of each type of pasture and were completed by dividing each AUM total in this line by 13,400.7. Percentage values for the province for each type of pasture are not additive from the regional percentage columns.

percent, and crop residue third at 12.4 percent. Pasture classified by respondents as Improved Native provided 6.4 percent with only one-half the output of Crop Residue. Even the aggregate production of Irrigated Tame and Irrigated Native produced only 2.2 percent of the total AUM in Alberta in 1964. However, irrigated pasture was important in Region III as indicated by intraregional comparison.

Tenure of Grazing Lands¹

Of the 19.3 million acres of pastureland in the province, 55.8 percent was privately owned, and 44.2 percent was leased from public agencies (Table 9). Most of the privately owned land (85.3 percent) was utilized by the land owners themselves, and the remainder was rented.

The 6.3 million acres grazed as crop residue was essentially all privately owned land; hence when it was included in the total pasture acreage, the portion of land leased from public agencies declined to one third.

While most of the improved pastureland and pastured crop residue was privately owned and used by landowners themselves, irrigated native pasture was the exception, 42 percent was leased land, one half was rented and only 7 percent was used by the owners. Of the unimproved pasture nearly half was leased.

Unimproved native pasture was the largest part of the grassland in each tenure group--75, 85, and 95 percent for owned, rented, and leased land respectively. Practically all the remainder of the leased land was unimproved native. Of owned land, 15 percent was tame pasture.

¹ Again excluding certain public lands as noted on page 13.

TABLE 9
PASTURE ACREAGE CLASSIFIED BY TYPE AND TENURE

Tenure	Unimproved Native	Improved Native	Tame	Irrigated Tame	Irrigated Native	Total Pasture	Crop Residue	Total including Crop Residue
	(thousands of acres)							
Owned ^a	6,942	800	1,375	89.7	1.7	9,208.4	5,429	14,637.4
Rented ^b	1,337	122	155	4.2	12.3	1,590.5	898	2,488.5
Leased ^c	8,066	406	50	.3	10.3	8,534.6	17	8,551.6
Total	16,345	1,330	1,540	94.2	24.3	19,333.5	6,344	25,677.5

^a Owned land - privately owned land used by the landowner.

^b Rented land - land owned by one private individual or group and rented to another.

^c Leased land - land leased from a public agency. Community pastures, grazing reserves and other public lands jointly used on a per load per month basis were not included

Pasture Production and Land Ownership

Approximately 13.4 million animal unit months (AUM) of grazing were derived from the 25.7 million acres grazed. The grazing of owned land supplied 70 percent of the total forage, rented land 10 percent, and leased land 19 percent (Table 10). Estimates for public or "leased land" were not all inclusive in this study.¹

Over 60 percent of the total grazing came from unimproved native pastures. Such pastures were particularly heavy contributors to the grazing provided by rented and leased land but supplied only half of that derived from owned land. The contribution of tame pasture to forage production was largest from owned pastureland, 24.3 percent on rented and 1.2 percent on leased grazing land. Crop residues came almost exclusively from owned and rented land and produced 12.4 percent of the AUM for the province during 1964. Improved native pastures were of equal importance to all tenure groups.

Owned land provided the largest portion of the grazing derived from all types of pasture except irrigated native pasture. Leased land was second on all classes of native pasture. Rented land accounted for the largest portion of grazing from irrigated native pasture. It ranked second as a contributor to forage production from tame pasture, irrigated tame pasture, and crop residue.

Owned land provided more grazing relative to its acreage than did leased land. No doubt differences in productivity have influenced historically the pattern of land tenure.

¹ For public lands not included in this phase of the study, see the footnote on page 13.

TABLE 10

ANIMAL UNIT MONTHS OF GRAZING PROVIDED BY EACH TYPE OF PASTURE CLASSIFIED BY TENURE

Type of Pasture		Owned	Rented	Leased	Total
(AUM in thousands)					
Unimproved Native	(AUM)	4,710.9	982.2	2,418.9	8,112.0
	Percent	50.1 ^b	70.6 ^b	93.0 ^b	60.6 ^b
Improved Native	(AUM)	616.6	101.4	144.2	862.2
	Percent	6.5 ^b	7.3 ^b	5.5 ^b	6.4 ^a
Tame	(AUM)	2,290.9	149.6	30.5	2,471.0
	Percent	24.3 ^b	10.7 ^b	1.2 ^b	18.4 ^a
Irrigated Tame	(AUM)	269.6	13.3	1.1	284.0
	Percent	2.9 ^b	1.0 ^b	--	2.1 ^a
Irrigated Native	(AUM)	2.7	3.7	3.1	9.5
	Percent	.1 ^b	.3 ^b	.1 ^b	.1 ^a
Crop Residue	(AUM)	1,517.5	140.5	4.0	1,662.0
	Percent	16.1 ^b	10.1 ^b	.2 ^b	12.4 ^a
Provincial Summary	(AUM)	9,408.2	1,390.7	2,601.8	13,400.7
	Percent	70.2 ^c	10.4 ^c	19.4 ^c	100.0

^a Percentage of AUM in Alberta obtained from this type of pasture from all three tenure classes.

^b Percent of AUM provided by pasture type within each tenure class.

^c Percent of AUM controlled by each tenure group (all pasture types included).

A regional comparison of acreage and animal unit months of grazing on owned, rented, and leased land, is given in Table 11. Note that grazing from owned land exceeded the acreage owned on a percentage basis in all cases but one (Table 11). In Region VI the proportions were essentially the same. Leased land again did not produce grazing in proportion to its acreage except in Region I. Rented land failed to show any definite trend.

TABLE 11
PASTURE ACRES AND PRODUCTION BY TENURE WITHIN REGIONS¹

Region	Owned		Rented		Leased	
	Acres	AUM	Acres	AUM	Acres	AUM
	(percent)					
I	20.1	26.3	7.4	1.8	72.5	71.9
II	60.8	72.8	5.5	7.0	33.7	20.2
III	32.9	56.8	4.3	4.4	62.8	38.8
IV	65.2	75.0	11.5	12.3	23.3	12.7
V	64.2	69.1	16.8	18.9	19.0	12.0
VI	82.7	82.3	12.4	13.6	4.9	4.1
VII	77.3	84.1	5.9	6.2	16.8	9.7
VIII	66.9	72.6	4.9	3.0	28.2	24.4
Province	57.0	70.2	9.7	10.4	33.3	19.4

¹ Includes crop residue grazed.

Unimproved native pasture was the only classification with sufficient observations to allow a comparison of owned and leased pastures according to pasture type (Table 12). In all regions except III, privately owned unimproved native pastureland provided more grazing per acre than did the public lands of this type. There was essentially no difference in the utilization of owned and leased land in Region III. In Region I the difference in the utilization was not large. Regions I and III secured most of their unimproved native pasture from leased land. Possibly the management practices used for leased lands under public guidance were found satisfactory and applied to all pastures of this type with little concern as to tenure. In regions where leased pastureland of this type was less than 50 percent of pasture acreage, the difference in rate of grazing was substantial.

Condition of Pasture as Estimated by the Respondents

Respondents were asked to select from a group of four pictures of grassland the one which most nearly represented their individual pastures at the end of the 1964 grazing season. This technique was employed to obtain the respondents' estimated pasture condition pastureland. The data may have an upward bias since the question of condition was vital, particularly if leased land was concerned. Moreover, cattlemen hold varying opinions and prejudices about pasture condition. A summary of this part of the study is given in Table 13.

Both unimproved native and improved native pastures were reported to be in better condition than the other two classes shown (Table 13). Leased land of which one half ranked good or excellent constituted large

TABLE 12

ANIMAL UNIT MONTHS OF GRAZING PER ACRE PROVIDED ON UNIMPROVED NATIVE PASTURE CLASSIFIED BY TENURE

Region	Owned	Rented	Leased
I	.35	.28	.25
II	.53	.77	.36
III	.33	.21	.32
IV	.87	1.21	.38
V	.63	.63	.33
VI	.97	.91	.62
VII	.62	.72	.34
VIII	.46	.56	.28
Province	.68	.73	.30

TABLE 13

CONDITION OF VARIOUS TYPES OF PASTURE

	Unimproved Native	Improved Native	Tame	Irrigated Tame
Excellent	7.4	12.4	5.0	3.1
Good	34.9	25.7	23.7	50.1
Fair	38.2	43.4	40.4	18.8
Poor	<u>19.5</u>	<u>18.5</u>	<u>30.9</u>	<u>28.1</u>
	100.0	100.0	100.0	100.0

portions of both these types of pasture, about 50 and 30 percent, respectively.

Much of the tame pasture was classed as poor, probably due to the fact that the majority of the tame grassland was in the northern regions, where there was little concern for carryover. Irrigated tame pasture, despite having 28.1 percent listed as being in poor condition, would seem to have been reasonably well cared for since 50 percent was reported in good condition.

A Comparison of Public and Private Lease Rental Rates and Length of Term

Due to the uncertainty and secrecy surrounding land tenure, the response to the questions concerning lease terms and charges was low. On the question of the length of lease the response was 58.8 percent, but the question concerning lease costs received replies from only 42.8 percent of those to whom the question applied.

Length of Lease

Over the province the respondents indicated that the length of the public leases held was approximately 13.5 years on the average. This compared with 2.5 year terms on private lands (Table 14).

The term of public leases was longer than average in Regions I and V. Of the private leases only the length of those in Region I, 9.3 years, differed widely from the average. This was, in part, a result of the large number of long term public leases in that area.

Rental Charges on Pastures

The charge for grazing on public land was less than on private pastures. Rates per AUM on private land were approximately 1.8 times greater than those paid on public grazing lands. Only Region II reported

TABLE 14

LENGTH OF LEASES - PUBLIC AND PRIVATE

Region	Public Lease (Years)	Private Lease
I	17.7	9.3
II	6.3	2.4
III	7.6	1.4
IV	9.1	3.0
V	16.9	2.8
VI	7.5	1.9
VII	6.4	1.2
VIII	7.1	2.3
Average ^a	13.2	2.5

^a Average weighted by number of observations in each region.

a charge on private lands less than that on public. Data from respondents on rental rates paid in 1964 were converted to cost per AUM for purposes of comparison and are given in Table 15.

What Farmers Would Pay for Grazing Within Selected Distances

Respondents indicated that they would be willing to pay \$2.57 per month to graze a cow and calf on good grazing land within 30 miles of their farm if supervision were provided (Table 16). If they had to move up to 60 miles, they would be willing to pay only \$2.15 for the same pasture. Region VII was the extraordinary case. If the pasture was within 30 miles, the average operator would be willing to pay \$3.52 per month,

TABLE 15

PASTURE RENTAL RATES ON PUBLIC AND PRIVATE PASTURE

Region	Charge on Public Lands	Charge on Private Lands
(Dollars per AUM)		
I	.80	1.13
II	.47	.33
III	.82	--
IV	.68	3.04
V	1.22	1.67
VI	.62	1.03
VII	.48	.57
VIII	1.82	2.14
Average ^a	.85	1.52

^aAverage is weighted by the number of observations in each region.

TABLE 16

RENTAL RATES STOCKMEN WOULD PAY FOR SUPERVISED PASTURE

Grazing Region	Pasture Within 30 Miles	Pasture Within 60 Miles
(Dollars per month for cow and calf)		
I	2.09	2.00
II	2.51	2.19
III	2.75	2.05
IV	2.77	2.73
V	2.41	2.27
VI	2.31	2.21
VII	3.52	1.83
VIII	2.17	1.95
Provincial average	2.57	2.15

the highest rate reported by any region. If the pasture was up to 60 miles away however, they would only pay \$1.83, the lowest rate quoted.

About 40 percent of the operators in the province said they were willing to move cattle up to 30 miles to pasture (Table 17). Only 17.7 percent were willing to move cattle up to 60 miles for grazing. Respondents in Regions VII and VIII were more reluctant to move cattle than were farmers of other regions, particularly those in Regions III, where 70 percent would have moved 30 miles and 40 percent would have been willing to move cattle up to 60 miles.

TABLE 17

PERCENTAGE OF ALL STOCKMEN WILLING TO MOVE CATTLE TO PASTURE

Grazing Region	Willing to Move Cattle up to 30 Miles (percent)	Willing to Move Cattle up to 60 Miles
I	48	25
II	41	16
III	70	40
IV	51	21
V	44	19
VI	38	12
VII	23	7
VIII	8	2
Provincial Average	40.4	17.7

CHAPTER III

THE IMPROVEMENT AND DEVELOPMENT OF PASTURELAND

This chapter provides an estimate of the potential resources yet available for use as pasture. Estimates are presented for potential improvement of privately owned pasture and for the development of additional privately owned land for pasture. Some insight to the cost of expanding the province's grassland comes from an examination of costs experienced by those improving pastureland. The question, why farmers were not making more pasture improvement, was investigated. A comparison of those making improvements on their pastures and those not doing so reveals some reasons supporting the actions of each group.

Farmers were asked to estimate the number of acres of pastureland they owned which could be profitably improved to increase carrying capacity. The necessary improvement practice or practices were also recorded. Fourteen individual improvement practices were considered as well as one "other" classification. The improvement practices were classified into two broad groups, (1) those which provided physical improvement of the pasture, i.e., clear land, reseed; and (2) those which allowed greater utilization of the already existing grassland, i.e., fall pasture crops, feed concentrate.

Potential for Pasture Improvement

For privately controlled pastureland in Alberta, data from respondents indicated that 59 percent or 11.4 million acres could have been improved (Table 18). The data in Table 18 provide a rough approximation of the potential for improvement. An overestimation exists because the

TABLE 18

REGIONAL AND PROVINCIAL ACREAGE ON WHICH RESPONDENTS THOUGHT VARIOUS IMPROVEMENT PRACTICES WOULD BE PROFITABLE

	I	II	III	IV	V	VI	VII	VIII	Province
	(thousands of acres)								
Clear land				12	84	334	56	426	912
Control of brush	1.7			299	306	421	63		1,090.7
Seed to tame grass	452	219	135	266	366	641	671	279	3,029
Fertilizer	22	154	372	122	142	450	180	49	1,491
Rotate grazing	27	109	56	183	535	155	9.1	82	1,156.1
Irrigate	15	28	40	17	45	8.4			153.4
Additional facilities for water	980	164	15	186	775	12	43	125	2,300
Fence to improve use	16	116	30	37	47	210	73	29	558
Control weeds		6.6	1.6	87	38			1.8	135
Distribute grazing with salting locations	23	48	2.6	15	31				119.6
Maintain adequate carryover	90			13	27	55			185
Drainage		.9	.7	1.2	16	25	71	15	129.8
Fall pasture crop				3.4	19				22.4
Feed concentrate		4.5	3.4		27				34.9
Other	22		3.8	1.4	33	10	18		88.2
Total	1,648.7	850.0	660.1	1,243	2,491	2,321.4	1,184.1	1,006.8	11,405.1
Percent of the Pastureland ^a of the region	29.2	89.2	49.7	41.2	89.3	94.1	61.6	88.5	59.0

^a Pastureland here includes the acreage grazed as crop residue.

data is based on acres to be improved by each practice and in certain instances two or more practices applied to the same area. More exact estimates of potential acreage for improvement and for the potential increased grazing attributable to each practice are given in the next chapter on linear programming.

Generally the group of practices reported within a region was dominated by a few which would provide most of the improvement. Seven improvement practices were of major importance. These practices--clear land, control of brush, seed to tame grass, fertilize, rotate grazing, irrigate, and add water facilities--affect 88 percent of the acreage which could be subject to improvement.

Over 80 percent of the acreage that could be cleared of trees and brush was in Regions VI and VIII. Most of the acreage which required brush control was in Regions IV, V, and VI. Land which could be reseeded was fairly evenly distributed across the province. A large potential for the use of fertilizer existed in Regions III and IV. Stockmen in Region V believed they could profit from further use of rotational grazing. Of the acreage that could be improved by irrigation about 30 percent was in Region V. Over 73 percent of the acreage which respondents thought to benefit from additional water facilities was found in Regions I and V. Fencing to improve pasture was needed primarily in Regions II and VI. Weed control was reported in Region IV, while it appeared Region VII could benefit from the drainage of pastureland.

Improvement Practices Used in 1964

Over 70 percent of the farms of the province reported pastureland which could be improved. In 1964 one fourth of these farms attempted

some form of pasture improvement on almost two million acres (Tables 19 and 20). Almost all the farms in Region III reported pasture which could be improved. In that region 63.3 percent of the farmers made some improvement in 1964, a remarkable proportion relative to the other regions. The opposite extreme existed in Region VIII, where less than one half the farms reported pasture which could have been improved, and fewer than 10 percent had made any improvement.

A comparable estimate of the rate of improvement obtained by comparison of the portion of an improvement practice thought profitable with the portion of that practice used in each region indicated many regions were adopting one particular practice more rapidly than the other regions (Table 21). In Region III where over 60 percent of the farms improved pasture in 1964 most improvements must have been on a small scale. In Region VIII the relatively few farmers who were interested in or made pasture improvement and that region's failure to lead in the rate of adoption of any improvement program indicated that this Region was lagging in pasture improvement.

The Development of Pastureland

Potential Land to Development as Pasture

There were approximately 1.67 million acres of privately owned land which could have been profitably developed as pastureland (Table 22). Almost 65 percent of this acreage was found in the three most northern regions. Over one fifth of the farms of the province reported land which could profitably be developed as pasture. On these farms an average of 100 acres were available for development.

TABLE 19

THE PERCENTAGE OF FARMERS REPORTING PASTURE TO IMPROVE AND THE PERCENTAGE WHO MADE IMPROVEMENTS IN 1964

	I	II	III	IV	V	VI	VII	VIII	Province
Percentage of farms reporting pasture which could be im- proved	72.7	57.8	98.0	81.3	65.9	77.3	75.7	48.7	72.1
Percentage of those reporting improveable pasture who made some improvement	28.7	29.2	63.3	29.7	21.8	26.9	19.6	9.5	26.2

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TABLE 20

ACREAGE OF PASTURE IMPROVEMENT COMPLETED BY PRACTICE AND BY REGION IN 1964

	I	II	III	IV	V	VI	VII	VIII	Province
	(thousands of acres)								
Clear land	--	--	--	1.7	2.3	5.4	34	9.1	52.5
Control brush	--	--	--	12	2.5	14	1.4	--	29.9
Seed to tame grass	51	3.2	6.4	14	16	37	16	.7	144.3
Fertilize	--	21	19	61	15	78	23	1.8	2.88
Rotate grazing	20	56	24	154	225	88	--	--	567.0
Irrigate	4.9	8.4	26	1.0	51	--	--	--	91.3
Additional facilities for water	43	136	1.4	27	--	5.6	--	--	213.0
Fence to improve use	--	280	5.5	16	--	24	23	--	348.5
Control of weeds	--	--	.9	7.1	.7	--	--	--	8.7
Distribute grazing with salting locations	45	--	--	--	110	--	--	--	155.0
Maintain adequate carryover	37	--	--	13	--	55	--	--	105.0
Drainage	--	--	--	.7	--	--	--	--	.7
Fall pasture crop	--	--	--	3.4	4.6	--	--	--	8.0
Feed concentrate	--	3.9	1.9	--	--	--	--	--	5.8
Other	--	--	--	1.4	8.8	2.2	--	--	12.4
Total	200.9	508.5	85.1	312.3	435.9	309.2	97.4	11.6	1,960.98
Percent of the acreage to improve	12.2	59.8	12.9	25.1	17.5	13.3	8.2	1.5	17.8

TABLE 21

FOR MAJOR IMPROVEMENT PRACTICES, THE ACREAGE IMPROVED DURING 1964 AS A PERCENTAGE OF THE ACREAGE REMAINING WHICH FARMERS THOUGHT THEY COULD IMPROVE

	I	II	III	IV	V	VI	VII	VIII	Total
Clear land	--	--	--	3.2	4.4	10.3	64.8	17.3	100.0
Control brush	--	--	--	40.1	8.4	46.8	4.7	--	100.0
Seed to tame grass	35.4	2.2	4.4	9.7	11.1	25.6	11.1	.5	100.0
Fertilize	--	9.6	8.7	27.9	6.9	35.6	10.5	.8	100.0
Rotate grazing	3.5	9.9	4.2	27.2	39.7	15.5	--	--	100.0
Irrigate	5.3	9.2	28.5	1.1	55.9	--	--	--	100.0
Additional facilities for water	20.2	63.8	.7	12.7	--	2.6	--	--	100.0
Fence to improve use	--	80.3	1.6	4.6	--	6.9	6.6	--	100.0
Control of weeds	--	--	10.3	81.6	8.1	--	--	--	100.0

TABLE 22

PRIVATELY OWNED LAND AVAILABLE TO DEVELOP FOR PASTURE AND THE PERCENTAGE OF FARMS REPORTING SUCH LAND

	I	II	III	IV	V	VI	VII	VIII	Province
(thousands of acres)									
Total acres	51	89	51	175	220	306	438	338	1668
Portion of the total	3.1	5.3	3.1	10.5	13.2	18.3	26.2	20.3	100.0
Percent of farms in that region	10.9	22.9	30.0	16.5	20.2	19.5	36.9	8.5	22.6

TABLE 23

THE TYPE OF LAND WHICH WOULD BE DEVELOPED AS PASTURE

	I	II	III	IV	V	VI	VII	VIII	Province
Abandoned cropland	1.1	3.2	5.2	.7	.7	.2	--	--	1.4
Virgin land	5.9	10.1	46.7	16.5	26.4	31.8	32.9	27.9	24.8
Cropland	92.6	71.4	45.5	81.5	66.4	22.6	6.4	8.8	49.4
Idle land	.4	15.3	2.6	1.3	6.5	45.4	60.7	63.3	24.4
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

The number of farms reporting land to develop as pasture was relatively low in Regions I and VIII. In Region I there was little land not used in pasture yet capable of being developed. In Region VIII, however, it was more likely that if land were to be developed most farmers would put it into cropland in preference to pasture. Region VII had the largest portion of farms reporting the largest acreage to develop as pasture.

The type of land which operators would commit to grass production varies throughout the province. Cropland would provide one half of the land to be developed as pasture (Table 23). Cropland was a particularly large contributor in Regions I through V, virgin land was the next largest contributor, and of first importance in Region III. Virgin land and idle land (which may have had the same characteristics) provided the largest potential for development in Regions VI, VII and VIII. Cropland was of minor importance in Regions VII and VIII. In no region was there a substantial amount of abandoned cropland to develop for pasture.

Land clearing and seeding to tame grass constituted over 80 percent of the acreage involved in pasture development (Table 24). These two improvements would likely produce the greatest additional amount of pasture.

Land Developed for Pasture in 1964

Practices used to develop private land for pasture were applied to 87,200 acres in 1964 (Table 25). This total was not adjusted to account for the use of two or more practices on the same acreage. If, however, the ratio of the acreage developed to the acreage on which individual practices were applied was the same for development completed as for potential develop-

TABLE 24

DEVELOPMENT PRACTICES NECESSARY TO PROVIDE PASTURE

	I	II	III	IV	V	VI	VII	VIII	Province
	(thousands of acres)								
Clear land	--	--	--	26.9	50.3	181.5	366.1	222.8	847.6
Prepare seedbed and seed to tame grass	50.0	38.7	48.6	144.4	143.6	191.2	339.4	237.3	1193.2
Control brush	--	--	--	--	--	--	--	2.4	2.0
Drain	.6	8.6	.3	1.6	11.1	24.3	47.6	13.9	108.0
Irrigate	1.5	3.7	16.0	--	--	--	--	--	21.2
Fence	5.3	1.5	--	14.6	13.9	67.9	75.2	132.0	310.4
Provide water for stock	--	3.0	--	--	18.7	1.1	--	--	22.8
Other	<u>.2</u>	<u>3.0</u>	<u>--</u>	<u>1.4</u>	<u>--</u>	<u>2.2</u>	<u>4.9</u>	<u>--</u>	<u>11.7</u>
Total ^a	57.6	58.5	64.9	188.9	237.6	468.2	833.2	608.4	2517.3

^a Column totals do not equal total acres to develop since more than one practice may apply to the same acreage.

TABLE 25

ACREAGE OF PRIVATELY OWNED LAND DEVELOPED FOR PASTURE IN 1964¹

	I	II	III	IV	V	VI	VII	VIII	Province
	(thousands of acres)								
Clear land	--	--	--	2.7	.5	6.3	6.7	4.8	21.0
Prepare seedbed and seed to tame grass	4.3	2.1	4.7	3.6	12.2	15.4	3.3	4.8	50.4
Drain	--	--	--	--	--	--	.9	--	.9
Fence	--	--	--	4.7	1.8	.8	7.4	.2	14.9
Total	4.3	2.1	4.7	11.0	14.5	22.5	18.3	9.8	87.2

¹ The figures give the acreage upon which each practice was used and does not adjust for the use of more than one practice on any given acreage.

ment (66.3 to 100), then approximately 57,800 acres were developed.

Development of pastureland appeared to be relatively lower in the three northern regions than in other areas. Whereas 75.9 percent of the acreage to develop was in Regions VI, VII, AND VIII, only 58 percent of the development occurred in these same regions.¹

Costs of Improving and Developing Pastureland

Information concerning the costs of improving or developing pastures were collected from a number of sources. Respondents in the general survey who had improved or developed pasture in 1964 reported the costs incurred using various techniques. Also those having potential land for development estimated the costs of converting this acreage to pasture. Finally, the mail questionnaires provided additional data concerning the cost of improvements.

To obtain cost estimates the costs of improvement and development actually experienced were combined (Table 26). This combination reduced the possibility that extreme values would bias the data. The estimated costs of development were excluded from this averaging since they consistently exceeded those experienced in practice (see Appendix A). The average cost for each practice within each region was determined by weighting the cost from each source by the acreage upon which the cost was observed. Average cost for the province was determined by weighting each regional cost by the acreage to which it applied.

¹ Both percentages are on the same basis with no adjustments made for the double counting of several practices on the same acreage.

TABLE 26

REPORTED COSTS OF PASTURE IMPROVEMENT AND DEVELOPMENT FROM ALL SOURCES ¹

	I	II	III	IV	V	VI	VII	VIII	Provincial Average
	(Dollars per acre)								
Clear land	-	-	-	15.12	25.97	16.21	18.85	19.36	18.93
Central brush	9.03	9.03	-	18.47	3.59	6.02	3.97	4.06	6.25
Break land ^a	-	-	-	12.32	13.68	16.23	11.86	11.86	13.56
Seed to tame grass	3.03	3.92	9.23	7.56	4.15	5.08	6.72	6.40	5.96
Fertilize ^b	-	6.73	4.06	3.79	3.99	3.96	3.96	-	4.49
Add water facilities	.66	.11	9.69	.97	1.80	1.15	-	-	.56
Irrigate - reported improvement costs	9.66	4.40	5.81	3.33	-	-	-	-	7.33
Mail questionnaire	-	-	34.68	-	49.33	-	-	-	35.65

¹ Regional averages weighted by regional acreages^a From mail-in cost questionnaire^b From reported improvement costs

The provincial average cost of clearing land was \$18.93 per acre and that for breaking \$13.66. The costs of brush control varied widely. It was particularly high in Region IV, suggesting that control by clearing may have been included. The average costs of \$6.25 were higher than those cited in a recent Department of Agriculture Publication.¹ Farmers who used fertilizer to improve pasture spent about \$4.50 per acre.² Adding watering facilities cost .56¢ per acre but regionally the costs varied widely. The average cost per acre of improving pastureland by irrigation was \$7.33. This low value applied to simple systems such as those where dams on natural waterways hold spring run-off which was periodically released to floor lower areas. The costs as obtained from the mail questionnaire were substantially higher, \$35.65 per acre, suggesting more sophisticated systems.

Factors Influencing Pasture Improvement

Respondents to the mail questionnaire reported substantially increased carrying capacity resulting from the use of improvement practices (Table 27). Ninety-five percent of this group felt the improvements they had undertaken had been profitable. Given that such returns were possible, why did many farmers not improve or develop additional pasture?

¹ The \$4.56 per acre compared closely with costs listed in Canada Department of Agriculture, Brush Control in Western Canada, Publication 1240, (Ottawa: 1965), 26.

² For further detail concerning fertilizer use see Appendix A.

TABLE 27

ESTIMATED INCREASE IN CARRYING CAPACITY RESULTING FROM PASTURE IMPROVED
BY ALL METHODS FROM 1962 to 1964¹

Increase in the Carrying Capacity	Percentage of Farmers Experiencing this Increase
25%	17.8%
50%	24.0%
75%	6.6%
100%	41.9%
Other ^a	9.7%

¹ Data from mail questionnaire

^a Mean increase for this group was 438%

Reasons Why Farmers Did Not Develop or Improve Pasture

The existence of better uses for limited capital was the major reasons restricting pasture improvement, particularly in regions other than I and II (Table 28). Seventeen percent were unable to find time to do further improvement. Some individuals found credit a limiting factor. This restriction was relatively more important in Regions II, III, and VII. Only respondents in Region I noted risk as a primary factor hindering development.

The frequency of failure when reseeding to tame grass can substantially affect the costs of improving pastures. Although most respondents to the mail questionnaire were usually successful, 11 percent often experienced failure (Table 29).

TABLE 28

REASONS FOR NOT DEVELOPING OR IMPROVING LAND FOR PASTURE

Reason	I	II	III	IV	V	VI	VII	VIII	Province
Better use of capital	15.3	16.2	24.6	23.6	26.2	26.7	30.1	28.6	25.3
Lack of time	18.8	10.3	15.4	15.9	18.3	17.1	22.8	13.9	17.1
Unable to obtain credit	4.7	16.2	15.4	10.0	3.7	8.0	17.4	4.9	9.8
Too risky	15.3	1.4	4.6	4.7	7.5	3.9	1.3	-	4.5
Lack of information	5.9	5.9	1.5	3.5	3.7	1.4	.9	-	2.4
Fully developed	13.0	23.5	18.5	12.9	15.0	13.8	9.6	22.8	15.1
Other reasons	27.0	26.5	20.0	29.4	25.6	29.1	17.9	29.8	25.8
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

¹ Similar tables separating those with land to develop and those with land to improve are in Appendix A.

TABLE 29

FREQUENCY OF FAILURE WHEN SEEDING GRASS¹

Never	45.4%
Seldom	43.8%
Often	10.8%
	<hr/>
	100.0%

¹ Data from mail questionnaire

The respondents of the mail survey from the irrigation and northern prairie districts appeared to have higher failure rates when seeding native pasture or abandoned cropland to tame grass than those of the other areas including the southeast (see Appendix A). In fact only seven percent of those in the southeast who seeded tame grass on abandoned cropland often experience failure. The data indicate that the rate of failure in new seedings was not as great as some believed.

Very few considered the lack of information a serious hindrance to further improvement. In Regions I and II, however, this reason was more important than elsewhere. Prime sources of information were the District Agriculturalist and farm magazines (Table 30). Government Research Stations ranked third overall but were slightly more important in the southern regions. The experience of other farmers was an aid to many. Sixty percent of the operators questioned with the mail questionnaire obtained results equivalent to their expectations indicating that most were well informed.

TABLE 30

THE IMPORTANCE OF VARIOUS SOURCES OF INFORMATION¹

	Percent
District Agriculturist	28.2
Farm Magazines	25.2
Government Research Station	18.0
Farmer who had improved his pasture	13.2
Other sources	11.2
Neighbor	4.2

¹ Data from mail questionnaire

More than one-third (36.8 percent) experienced results better than they had expected. Only 3.2 percent were disappointed. No explanation can be offered as to why a possible 1.7 percent of the farmers reported improvement practices expecting they would not be profitable.

A number of respondents (15 percent) claimed their land was fully developed, despite having noted an acreage which they said could be further improved or developed. It is suggested that these farmers likely felt that as far as they were personally concerned the land was fully developed since they did not intend to make further improvements. Possibly their reasons would have fit better into the "other" grouping.

Other reasons for not developing or improving potential land accounted for one fourth of the reasons expressed (Table 31). Almost one

TABLE 31

OTHER REASONS WHY LAND WAS NOT DEVELOPED OR IMPROVED FOR PASTURE

Reason	Percent
Have sufficient pasture and not interested in more	31.4
Adverse weather prevented improvement	13.8
Age, health and/or impending retirement	10.9
Unable to obtain permission of neighbor or local government	2.1
Unable to forego present pasture production	1.8
Miscellaneous reasons	<u>40.0</u>
	100.0

third of this group had sufficient pasture and were not interested in more. Adverse weather hindered many farmers. A substantial group felt that due to age, illness, or impending retirement, further improvement was impractical.

Additional Factors Influencing Pasture Improvement

Of the farms on which there was potential land to improve or develop as pasture, approximately 28 percent carried out some improvement program in 1964. Comparing the farms which had undertaken some improvement program with those which had not, revealed a number of factors influencing the adoption of pasture improvement programs.

Few tenant farmers made improvements on pastureland (Appendix A). Only 16.7 percent of the tenant operators improved pastureland compared to

27.5 percent and 29.4 percent of the full owners and part owners, respectively.

Farmers with 10 to 30 years of operating experience appeared to be relatively more active improvers of pasture than those farming for greater or lesser periods (Table 32). The difference was most evident in those operating from 20 to 29 years. The reasons given for not improving pasture (or more pasture in the case of those who had improved some) were determined for each group of farmers with various periods of operating experience (Table 33). A high percentage of those farmers with over 30 years of experience felt that they had better uses for their capital.

It was noted from a comparison of Tables 25 and 27 of Appendix A that those who had made some pasture improvement were less limited by credit and felt that there were fewer, more profitable alternative uses for capital than those who had not used pasture improvement practices. Further comparisons of the two groups reveal other differences.

The total sales of the operators who made some improvement in 1964 were approximately 70 percent greater than the total sales of the non-improving group (Table 34). Only in Region VIII did the receipts of those improving pastureland fail to exceed receipts of those who did not improve or develop pastureland. The proportion of total sales received from cattle and sheep was greater on those farms which had made some improvement in 1964 than on the farms which had not done so in all regions except Region V. A part of this varying percentage of sales from cattle and sheep was accounted for by the fact that about 10 percent of the farms not making any improvement did not sell any stock in 1964.

TABLE 32

YEARS OF FARMING EXPERIENCE IN RELATION TO PASTURE IMPROVEMENT

Years of farming experience	Those who improved pasture (percent)	Those who did not improve pasture (percent)
1 - 9	9.5	11.4
10 - 19	30.3	28.0
20 - 29	27.2	20.1
30 or more	33.0	40.5
Total	100.0	100.0

TABLE 33

REASONS GIVEN BY RESPONDENTS FOR FAILURE TO IMPROVE ADDITIONAL PASTURE

Reason	Years of Experience			
	Less than 10	10-19	20-29	30 Plus
Better use for capital	25.4	25.5	31.9	36.2
Lacked time	13.6	15.5	14.8	19.4
Unable to obtain credit	13.0	10.1	11.0	8.3
Risk too great	4.5	7.4	3.9	3.8
Lacked information	.8	1.1	1.9	.9
Fully developed	4.2	7.4	6.5	3.7
Other	38.5	33.0	30.0	27.8
	100.0	100.0	100.0	100.0

TABLE 34

TOTAL SALES AND PERCENTAGE OBTAINED FROM CATTLE AND SHEEP OF THOSE IMPROVING AND NOT IMPROVING PASTURE
DURING 1964

Improvement Group	I	II	III	IV	V	VI	VII	VIII	Province
(dollars)									
<u>Made pasture improvement</u>									
Total income	11,976	20,816	16,550	24,742	19,507	9,177	5,400	3,324	14,218
Percent from cattle & sheep	49.4	61.2	54.3	64.0	27.8	40.7	45.3	26.4	49.5
<u>Did not make pasture improvement</u>									
Total income	9,784	10,900	6,931	12,945	13,925	7,069	4,261	4,882	8,311
Percent from cattle & sheep	45.9	30.6	35.7	52.4	31.8	33.7	33.7	17.2	37.1

Farmers who had improved pasture were more willing to move cattle up to 70 miles to pasture. The rates which the two groups of farmers are willing to pay for a month of grazing for a cow and calf were similar.

The acreage remaining as potential land for improvement or development as pasture was essentially the same for both groups--approximately 60 acres. The potential acreage yet to improve or develop did not appear to be a factor influencing the one who undertook pasture improvement programs.

Over 60 percent of the farmers agreed with the following statements:

- (a) Seeding native pastures with improved grasses will at least double carrying capacity;
- (b) Excluding rotation pastures, the cost of reseeding will be recovered within four years;
- (c) Seeding abandoned cropland with improved grasses will at least double carrying capacity.

In the northern areas a greater percentage agreed than in the southern regions. Overall, 12.8 percent to 15.7 percent said they did not know the answer. Only 3.7 percent felt the reseeding of pasture did not apply in their area, but 19.1 percent felt the reseeding of abandoned cropland did not apply. There was no difference in the opinions expressed by the improvers and the non-improvers.

Characteristics of Farms Noted for Having Improved Pasture

The farm operators contacted with the mail questionnaire had been identified by other members of the community as men who completed some

improvement or development practices on pasture. An examination of these farms provided additional information as to the type of farms on which improvement was initiated. These farms were generally larger than average for their region and had substantial numbers of cattle (Table 35). Approximately 75 percent of their acreage was in pasture, compared to less than 60 percent--the provincial average. The gross sales for this group were far above the provincial average. A total of 54.9 percent of these respondents had gross sales greater than \$40,000 (Table 36). The bi-modal distribution of gross receipts revealed that those farms with the very low and very high sales were relative to those with sales in the \$10,000 to \$40,000 range. This relationship suggested that much of the improvement was made by farmers with high incomes and by those who had to improve pastures to make the land sufficiently productive to provide a living.

A high proportion of the low-income farms with irrigated pasture made improvements. On the Grey Wooded soils almost all of those selected for having made improvement had high incomes.

Of the operators surveyed by mail, 84.3 percent obtained more than one half of their farm income from the sale of cattle, sheep, horses, and livestock products and 81.1 percent had gross sales in excess of \$20,000 in 1964 (Table 37). In essentially no case did the sale of such products represent less than one quarter of the farm income.

TABLE 35

CHARACTERISTICS OF FARMS CONTACTED WITH MAIL QUESTIONNAIRE

	Irrigation	Southeast	Northern			Grey		Provincial Average
			Prairie	Foothills	Black	Wooded	Wooded	
Total acreage	4,540	6,408	1,869	6,413	889	1,101		3,537
Acres owned	2,163	1,950	1,250	3,803	737	734		1,773
Acres of pasture	3,721	4,670	949	5,617	275	490		2,620
Number of cattle	336	323	164	484	160	116		256

TABLE 36

GROSS SALES FROM FARMS CONTACTED BY MAIL QUESTIONNAIRE

Region	Less than \$10,000	\$10,000- 19,999	\$20,000- 29,999	\$30,000- 39,999	\$40,000 49,999	Greater than \$50,000	Total
Irrigation	30.3	3.0	18.2	18.2	21.2	9.2	100.0
Southeast	26.6	0	6.7	6.7	30.0	30.0	100.0
Northern Prairie	6.5	9.7	9.7	29.0	41.9	3.2	100.0
Foothills	25.8	9.7	9.7	22.6	29.0	3.2	100.0
Black	13.0	4.3	6.5	17.4	41.3	17.5	100.0
Grey Wooded	1.4	2.9	7.2	14.5	31.9	41.1	100.0
Province	14.4	4.5	8.7	17.5	34.3	20.6	100.0

TABLE 37

PORTION OF GROSS SALES OBTAINED FROM THE SALE OF CATTLE, SHEEP, HORSES AND LIVESTOCK PRODUCTS OFF
FARMS CONTACTED BY MAIL QUESTIONNAIRE

None	One Quarter	One Half	Three Quarters	All	Total
.3	15.4	24.9	32.0	27.4	100.0

CHAPTER IV

THE LINEAR PROGRAMMING ANALYSIS

The Model

In this phase of the study the province was subdivided into six relatively homogeneous regions. These regions follow the pattern outlined earlier except that four of the eight were grouped into two. Regions I and II became one region called the Southeast. Regions VII and VIII were combined as one called the Grey Wooded district. Following this pattern, the other regions were also given names--Region III became the Irrigated Region, IV the Foothills, V was called the Northern Prairie, and VI became the Black Region.

To simplify analysis the model only considered beef production, the enterprise which will demand most of the increased grassland production. Furthermore, only the production of feeder stock, calves and yearlings from grass was considered. For the province as a whole, no import or export of cattle pastured or to be fed substantial quantities of forage was assumed. Cattle finishing enterprises were omitted because such operations use limited amounts of forage. No significant alternative feed source other than the forage produced on grassland was considered.

It was further assumed that pasture resources in their current state were fully utilized. Any increase in production above 1964 levels must arise from newly developed pastureland or pasture which had been subsequently improved. The model investigated only the production and use of additional grazing capacities. In no solution could the model reduce cattle numbers or grazing capacity of a region below the 1964 level. The

"worst" any region could do in this model was to remain at its 1964 level of production.

Each region had four possible beef production activities which included: (1) a cow calf operation producing stocker calves for sale to feedlots at weaning; (2) production of calves to be retained until yearlings and then sold as feeders; (3) production of calves to be sold to other regions at weaning (to be grown to feeder yearlings); and (4) production of feeder yearlings grown from calves purchased from other regions, wintered and pastured one season.

In addition to beef production activities, each region had a number of possible improvement activities which could have been used to generate pasture. Before cattle numbers could increase in a region, it was necessary for forage production activities to generate the required pasture and winter feed. No movement of forage among regions was permitted.

In summary, this study utilized the linear programming technique to solve a model representing regional competition within Alberta for the production of feeder cattle. Only increases in production above 1964 levels were considered. The model was required to generate livestock and necessary forage subject to profit maximizing conditions.

The Coefficients

It was important to obtain coefficients which were as representative of the regions as possible. Some information required was not readily available. The survey developed part of this information which was formerly lacking. As far as possible survey data were utilized. Where information

was still required, additional sources were used to augment the data. The coefficients represent a diligent attempt to provide the best possible estimate from available data.

The Potential Increase in Grazing Resulting from the Use of Improvement Practices

The different amounts of grazing obtained from various types of pasture were used, and, when necessary, adjustments were made to account for cases where land was being developed or pasture was being improved.

The potential improvement resulting from reseeding was determined from a comparison of the grazing per acre from unimproved native pasture and tame grass within each region (Tables 38 and 39). The benefit from irrigation was obtained by comparing the grazing rates on unimproved native range with that on irrigated tame pasture. The coefficient for response to irrigation in the Southeast included fertilizer application, while that in the Irrigation Region did not, because spreading fertilizer on irrigated pasture in the latter was considered a separate activity. The addition of more watering facilities was assumed to produce a 25 percent increase in utilization.¹ The increase was calculated on a weighted average of the grazing rates on all pastures of the region.

The response to fertilizer was estimated from research results of the Department of Soil Science, University of Alberta, and those of the experimental farms, research stations, and sub-stations throughout the

¹ A. Johnson and D. B. Wilson, "The Range Story of the Prairies", Agricultural Institute Review, XVII (January-February, 1962), 10.

TABLE 38
POTENTIAL INCREASE OF GRAZING FROM IMPROVEMENT PRACTICES WITHIN EACH REGION¹

	Southeast	Irrigation	Foothills	Northern Prairie	Black	Grey Wooded
		(AUM per acre)				
Reseed to tame grass	.697	1.090	.861	.772	1.072	1.031
Irrigate	4.684 ^a	2.768	--	--	--	--
Add water facilities	.082	--	.194	.149	--	--
Fertilizer irrigated pasture:						
grass-legume	--	1.916	--	--	--	--
grass	--	4.557	--	--	--	--
Fertilizer dry-land pasture						
grass-legume	--	1.140	2.04	1.140	1.862	1.282
grass	--	1.183	1.246	1.183	1.156	2.587
Control brush	--	--	.356	.271	.457	.487
Clear, break and seed to pasture	--	--	1.235	1.005	1.778	1.486

¹ Calculated prior to rounding off pasture acreages and the AUM of grazing.

^a Includes fertilizer (2.768 AUM increase for irrigation plus 1.916 AUM for fertilizer). The benefits of irrigation and of fertilizing irrigated pastures are assumed to be the same in all regions where applicable.

TABLE 39

GRAZING RATES IN ANIMAL UNIT MONTHS BY REGION AND TYPE OF PASTURE¹

Grazing Region	Unimproved Native	Improved Native	Tame	Irrigated Tame
(AUM per acre)				
Southeast ^a	.337	--	1.0	--
Irrigation	.320	--	1.325	2.997
Foothills	.712	1.112	1.322	--
Northern Prairie	.542	.642	1.161	--
Black	.915	1.127	1.940	--
Grey Wooded	.470	.964	1.547	--

¹ Based upon the total acreage and total sum of grazing calculated to rounding of figures as presented.

^a In the Southeast and Grey Wooded areas where two Regions I and II, and VII and VIII, respectively, were combined, the grazing rates were weighted in each region by the acreage to improve and develop.

province.¹ Response was measured both as a percentage increase and as an absolute increase in pounds of dry matter (Table 40). The latter measure was used to determine the increase in Animal Unit Months of grazing which could be expected assuming that 700 pounds of dry forage was equal to one animal unit month of grazing or winter forage. Responses on both grass-legume mixtures and pure grass swards were obtained. The response on irrigated pastures was based upon a limited number of observations.

Brush control was assumed to produce a 50 percent increase in carrying capacity over unimproved native pasture. The total increase resulting from clearing, breaking, and seeding land to pasture was estimated to be the grazing capacity of tame pastures, less .25 Animal Unit Month, the estimated carrying capacity of bush pasture prior to improvement.² Adjustment was made where necessary for the proportion of land being developed rather than improved.

The Cost of Pasture Improvement

The costs of various practices were determined by considering the physical work required under typical circumstances and charging for this at a normal rate so as to meet full costs (Table 41).³ These rates should approximate the charges for custom work in the area but were slightly lower since the figures used were based upon revised 1955

¹ Alberta Soils Advisory Committee, Soils and Fertilizer Test Results in Alberta, 1949-65, Confidential Report, Department of Soil Science, (Edmonton: University of Alberta).

² A. Johnson, et al, Alberta Guide to Range Sites, Condition Classes and Recommended Stocking Rates, Canada Agriculture Research Station, Lethbridge, and Alberta Department of Lands and Forests, Edmonton, Alberta, 24.

³ For more detailed report see Appendix E.

TABLE 40

RESPONSE TO FERTILIZER¹

	Irrigated Forage	Dark Brown Soil	Thin Black Soils	Black Soil	Grey Wooded Soil
<u>Grass-legume mixture</u>					
Percentage increase	30.6	43.0	67.0	75.9	50.0
Increase in pounds of dry matter per acre	1,341	798	1,428	1,303.4	897.3
Application per acre	100-30-0	18-23-0	33-31-0	31-33-0	32-29-0
Cost of fertilizer (dollars per acre)	14.70	4.22	6.77	6.70	6.41
<u>Grass Mixture</u>					
Percentage increase	1,087.6	52.0	57.1	59.6	161.8
Increase in pounds of dry matter per acre	3,190	828.5	872	645	1,345.7
Application per acre	187-0-0	22-11-0	38-0-0	38-0-0	39-0-0
Cost of fertilizer ^a (dollars per acre)	22.44	3.71	4.54	4.57	4.68

¹ Alberta Soils Advisory Committee, Soils and Fertilizer Test Results in Alberta, 1949-1965, Confidential Report, Department of Soil Science, (Edmonton: University of Alberta).

^a N at 12¢ per lb., P₂O₅ at 9¢ per lb., no charge for spreading.

TABLE 41

INITIAL OUTLAY REQUIRED FOR IMPROVEMENT PRACTICES

	Southeast	Irrigation	Foothills	Northern Prairie	Black	Grey Wooded
	\$ 4.84	(dollars per acre) \$ 4.84	\$ 6.89	6.89	\$ 8.89	\$ 9.56
Reseed to tame grass						
Irrigation	80.00	80.00	--	--	--	--
Add water facilities	.91	--	.91	.91	--	--
Fertilize irrigated pasture						
grass-legume	--	15.20	--	--	--	--
grass	--	22.94	--	--	--	--
Fertilize dryland pasture						
grass-legume	--	4.72	7.85	4.79	7.20	6.91
grass	--	4.21	5.04	4.21	5.07	5.18
Control brush	--	--	4.98	4.98	4.98	4.98
Clear, break and seed to pasture	--	--	41.03	41.03	41.03	38.22

machines costs.¹ If the average age of farm machinery is considered, the charges used are likely close to the full cost many farmers would experience. Recommended rates and mixtures for seeding pastures were followed, with prices for seed taken from a 1966 price list of a commercial seed supply company.

Irrigation costs were based upon costs reported by government agencies in the development of rangeland to irrigated pasture in the Lethbridge area. The cost of adding more watering facilities was estimated from survey data to be 11.1 cents per acre per year (Table 41).

The cost of fertilizer was based upon the rates of application obtained from research results and prices of 12 cents per pound of nitrogen (N) and nine cents per pound of phosphate (P_2O_5). An additional charge of 50 cents per acre for application was included in the coefficient.

The cost of brush control was determined from the costs noted in the recent Canada Department of Agriculture bulletin, Brush Control in Western Canada.² The average cost of mowing brush with a rotary mower was \$2.80 per acre. Chemical spray cost \$2.18 per acre. It was assumed that each practice would be used once so that an acre of brush would be treated twice, likely in successive years, with a total cost of \$4.98 per acre or \$.713 per acre per year when amortized over a ten year period (with interest at five percent).

¹ Alberta Department of Agriculture, Farm Machinery Rates - Alberta, Publication 825, (Edmonton).

² H. A. Friesen, et al, Brush Control in Western Canada, Canada Department of Agriculture, Ottawa, Publication 1240, (Ottawa: 1965), 26.

The cost of breaking and clearing land was calculated from the actual costs farmers experienced for these operations as determined from survey data. All costs included an interest charge of five percent per annum if the investment was made for more than a year. No interest charge was included in fertilizer costs but was included in the costs of the other practices whose benefits were assumed to extend over 10 to 20 year periods.

With the cost of improvements and the resulting increase in grazing, the cost of obtaining a sufficient increase in grass production to provide an animal unit month of grazing was calculated. Reseeding provided a relatively economical way of increasing carrying capacity (Table 42). Irrigation was expensive, even though substantially higher responses were obtained. The use of fertilizer to produce additional grazing was in most cases an expensive method of improving pasture production. Brush control provided grazing more economically than clearing, breaking, and seeding to tame grass.

Calculation of the annual costs as in Tables 41 and 42 but with the interest charge excluded reduced the costs for all practices except fertilization (Table 43). The practice which received the greatest cost reduction was clearing, breaking, and seeding to pasture since it had a high initial outlay making up the bulk of the total expense. The use of costs which omit interest charges may be justified by the fact that many operators fail to recognize or ignore the opportunity costs of their own funds when invested in such enterprises. Also the costs of such improvements as clearing are associated with increased land value, but no consideration of capital gain was made in the cost estimates.

ANNUAL COST OF IMPROVEMENT PRACTICES¹

¹ includes interest at 5%

^a includes fertilizer

^b includes a charge of \$.50 per acre for spreading

^c insufficient responses to make an accurate estimate so the cost in the Black Region was adopted.

TABLE 43

ANNUAL COST OF IMPROVEMENT PRACTICES EXCLUDING INTEREST

	Southeast	Irrigation	Foothills	Northern Prairie	Black	Grey Wooded
	(Dollars per acre)					
Reseed to tame grass	\$.343	\$.343	\$1.08	\$.927	\$1.014	\$1.018
Irrigate	41.90 ^a	26.70	--	--	--	--
Add water facilities	.091	--	.091	.091	--	--
Fertilize irrigated pasture						
grass-legume	--	15.20	--	--	--	--
grass	--	22.94	--	--	--	--
Fertilize dryland pasture						
grass-legume	--	4.72	7.85	4.79	7.20	6.91
grass	--	4.21	5.04	4.21	5.07	5.18
Control brush	--	--	.498	.498	.498	.498
Clear, break and see to pasture	--	--	2.69	2.69	2.69	2.54

^a includes fertilizer

The cost of one animal unit month of grazing obtained by using the several improvement practices, including the interest charge is given in Table 44. When interest charges are omitted a reduction in costs was obtained for all improvement practices except fertilization (Table 45). The largest reduction was made in the cost of clearing, breaking, and seeding tame grass.

Costs and Returns of Beef Enterprises

Cow Calf Operations--The annual costs of keeping a beef breeding cow vary between regions and on farms within regions. The lowest estimated cost was \$74.75 in the Southeast and the highest, \$92.33, in the Grey Wooded Region (Table 46). The data from which these costs were estimated were obtained from several sources. The costs for the Foothills, Northern Prairie, and Black Regions were taken from the analysis of farms in these areas obtained from the 1965 farm business analysis of the Provincial Department of Farm Economics.¹ The Foothills costs which were taken from this source were higher (primarily higher feed costs) than might have been expected considering the feeding period of this area as reported by Vrooman et al² and the 1962 ranch study done by the Canada Department of Agriculture.³ The data showed a pasture and winter forage cost greater

¹ The possibility of bias is admitted since the farmers participating in the farm management organizations were somewhat typical of the average farmers of these areas. This situation may have resulted in this group displaying below average costs since they were better than average managers. On the other hand, because they were somewhat more affluent than most they could afford practices in this enterprise which resulted in greater than normal costs.

² C. W. Vrooman, G. D. Chattaway and A. Stewart, Op. cit.

³ Feeding period data reported in J. D. MacKenzie, "Resource Requirements for the Production of Beef Calves and Yearlings in the Peace River Area of Alberta," Agricultural Economics Special Report 2, (Edmonton: Department of Agricultural Economics, University of Alberta, 1966).

TABLE 44

COST OF AN ANIMAL UNIT MONTH OF GRAZING GENERATED BY IMPROVEMENT PRACTICES

	Southeast	Irrigation	Northern			Grey	
			Foothills	Prairie	Black	Wooded	
(Dollars per AUM)							
Reseed to tame grass	\$.736	\$.471	\$1.57	\$1.50	\$1.18	\$1.23	
Irrigate	12.48	10.87	--	--	--	--	
Add water facilities	1.35	--	.572	.745	--	--	
Fertilize irrigated pastures							
grass-legumes	--	7.93	--	--	--	--	
grass	--	5.03	--	--	--	--	
Fertilize dryland pastures							
grass-legumes	--	4.14	3.85	4.20	3.87	5.39	
grass	--	3.56	4.04	3.56	4.39	2.00	
Control brush	--	--	2.00	2.63	1.56	1.46	
Clear, break and seed to pasture	--	--	3.84	4.72	2.67	3.00	

TABLE 45

COST PER ANIMAL UNIT MONTH OF GRAZING GENERATED BY IMPROVEMENT PRACTICES WHEN INTEREST CHARGES ARE EXCLUDED

	Southeast	Irrigation	Foothills	Northern Prairie	Black	Grey Wooded
	(Dollars per AUM)					
Reseed to tame grass	\$.492	\$.315	\$1.25	\$1.20	\$.946	\$.987
Irrigate	11.55	9.65	--	--	--	--
Add water facilities	1.11	--	.469	.611	--	--
Fertilize irrigated pasture						
grass-legume	--	7.93	--	--	--	--
grass	--	5.03	--	--	--	--
Fertilize dryland pasture						
grass-legume	--	4.14	3.85	4.20	3.87	5.39
grass	--	3.56	4.04	3.56	4.39	2.00
Control brush	--	--	1.40	1.84	1.09	1.02
Clear, break and seed to pasture	--	- -	2.18	2.68	1.51	1.71

TABLE 46

COW CALF OPERATION, COSTS AND RETURNS PER COW WITH OBSERVED CALF CROPS

	Southeast	Irrigation	Foothills	Northern Prairie	Black	Grey Wooded
	(Dollars per cow)					
Total cost per year	\$74.75	\$77.76	\$86.01 ^a	\$79.81 ^a	\$91.46 ^a	\$92.33
Pasture and winter feed	32.00	33.28	44.98 ^a	37.27 ^a	46.10 ^a	49.30
Total cost less pasture and winter feed ^a	42.75	44.48	41.03	42.54	45.36	43.03
Cost to put up required winter forage ^b	8.19	8.19	8.50	11.81	13.88	13.88
Total cost less forage	50.94	52.67	49.53	54.35	59.24	56.91
Percent calf crop ^d	78.8%	67.7%	82.0%	83.1%	79.5%	74.2%
Gross return per cow	74.08	65.48	76.56	77.03	68.91	66.55
Returns to meet pasture and winter forage costs ^c	23.04	12.81	26.03	22.68	9.67	9.64
Returns to meet pasture and winter forage costs if total costs are 10 percent less ^c	28.07	17.99	30.97	27.62	15.47	15.20
Returns to meet pasture and winter feed costs if the price for steer calves at Edmonton is 25¢ per lb. ^c	40.63	25.70	44.09	40.27	26.64	24.07

^a Data obtained from Provincial Department of Agriculture, Department of Farm Economics.

^b Calculated at \$6.00 per ton and 700 pounds of dry forage provide one AUM.

^c Cost of putting up winter feed not met from this return

^d Percent calf crop as reported by respondents in survey.

in the Foothills than the Northern Prairie Region where according to surveys the feeding period was longer. Costs in the Foothills other than pasture and winter feed were the lowest of all regions.

The costs of the Southeast Region were determined by adjusting the costs as calculated by Love.¹ A full value was placed on hay and a five percent return on capital was assumed to cover capital costs thus allowing the determination of total costs.

The costs of cow-calf operation in the Irrigation Region were basically those of the Southeast but modified to include the cost of raising cows on irrigated pasture as obtained from the Farm Business Report of the Irrigation District.²

Information from MacKenzie's study of beef production in the Peace River Region permitted the calculation of the cost of maintaining cows in the Grey Wooded Region.

Regional differences in costs of raising cattle were primarily due to variations in the cost of pasture and winter feed. All other costs vary over a range of \$41.03 to \$45.36, while pasture and winter feed charges vary from \$32.00 to \$49.30 per cow.

The cost of putting up winter feed was assumed to be \$6.00 per ton. Feed required for the winter feeding periods is given in Table 47. The feeding periods used for the Shortgrass and Foothills Regions were a

¹ H. C. Love, "Income Variation in Beef Production," Department of Agricultural Economics Research Bulletin 1, University of Alberta, (Edmonton: Department of Extension, University of Alberta, 1966), 31.

² A. R. Jones and L. Bauer, Farm Business Report, Irrigation District, 1964, (Edmonton, Alberta Department of Agriculture, Farm Economics Branch, 1965).

TABLE 47

WINTER FEEDING PERIODS FOR MATURE CATTLE

Source of Data	Vrooman et al ^a	Canada ^b Dept. of Ag.	MacKenzie ^b and Love	Coefficients Used in This Study
Region	(days) (1)	(days) (2)	(days) (3)	(months) (4)
Shortgrass	83	130	-	-
Foothills	99	144	-	4.0
Northern Prairie	127	-	-	5.1
Peace River	-	-	184	-
Southeast	-	-	-	3.5
Irrigation	-	-	-	3.5
Black	-	-	-	6.0
Grey Wooded	-	-	-	6.0

^a Vrooman et al, op. cit.

^b MacKenzie, op. cit.

compromise between those reported by Vrooman et al and Canada Department of Agriculture¹ data (Table 47). The period selected for the Northern Prairie was based on the Vrooman data but adjusted to show a longer period corresponding with the increase in the forementioned regions. The 184 day period was used for both the Black and Grey Wooded Regions.

Calculation of the returns per cow followed the pattern used to calculate the average returns over a twenty year period as reported by Love². Love assumed an 85 percent calf crop; therefore, for Matrix A, adjustments were made in all regions in order to reduce the gross return per cow to correspond with the respective regional calf crop percentages reported for 1964 in the pasture survey. Edmonton market prices were used for the Black and Grey Wooded Regions. This reduced the average price of calves in these two regions \$1.50 per hundred and that of cows \$.33.

When the total cost less pasture and winter feed (the cost of putting up winter feed included) were deducted from the gross returns per cow, the remainder was available to meet the cost of producing roughage for pasture and winter feed. These funds varied from \$9.64 in the Grey Wooded Region to \$26.03 in the Foothills. When costs were assumed to be 10 percent lower, the available returns to meet forage costs range from \$16.48 to \$32.07. The importance of the calf crop was evident. The Irrigation Region had low costs but small returns because the percentage calf crop was low.

¹ See MacKenzie, op. cit.

² Love, op. cit.

When an 85 percent calf crop throughout the province was assumed the returns available to meet forage production costs were higher in each case than when observed calf crops were used (Table 48). Those areas with the lowest calf crops appeared more efficient when the 85 percent assumption was made. The Foothills and Northern Prairie areas gained only moderately since each, in practice, secured a calf crop near to that assumed.

The possibility of higher prices for beef in the future required use of prices above the 20 year average. A price basis of 25¢ per pound for steer calves at Edmonton was selected, with corresponding adjustments made for other classes of stock and other marketing points. This assumption greatly enhanced the returns available to meet forage production costs.

The two northern areas were severely disadvantaged in the cow calf operations primarily due to the costs associated with long winter feeding periods. The Foothills, Northern Prairie, and Southeast Regions appeared as the most favored in the initial model, while under the assumption of an 85 percent calf crop in all regions the Irrigation area must be included with the latter group.

Raising Calves to Feeder Yearlings--The marketed animals were assumed to be 63.4 percent steers and 36.6 percent heifers.¹ The weight and price were adjusted accordingly when determining each for an average animal. Weights and prices reported by Love were used, except for the Black and Grey Wooded regions where the price was approximately \$1.50 per hundred less.² Calves were assumed to be purchased November 1 and wintered

¹ Assumes a calf crop half steers and half heifers with a 16% replacement rate.

² Love, op. cit.

TABLE 48

RETURNS PER COW IN COW CALF OPERATION IF 85 PERCENT CALF CROP ASSUMED

	Southeast	Irrigation	Foothills	Northern Prairie	Black ^b	Grey ^b Wooded
	(Dollars per cow)					
Gross returns per cow ^a	\$79.01	\$79.01	\$79.01	\$79.01	\$74.34	\$74.34
Returns to meet pasture and winter feed costs ^c	28.07	26.34	28.48	24.66	15.10	17.43
Returns to meet pasture and winter feed costs if total costs are 10 percent lower	33.08	31.52	33.42	29.99	20.90	22.99
Returns to meet pasture and winter feed costs if price for steer calves at Edmonton is 25¢ per lb.	43.78	42.05	44.19	39.37	29.09	32.42
Returns to meet pasture and winter feed costs if price is 25¢ per lb. and costs are 10 percent lower	48.87	47.32	49.14	44.80	35.01	38.11

^a Source: H. C. Love, "Income Variation in Beef Production", Department of Agricultural Economics Research Bulletin 1, University of Alberta, (Edmonton: Department of Extension, University of Alberta, 1966), 31.

^b Returns for Black and Grey Wooded Regions adjusted to reflect Edmonton prices (steers and heifers \$1.50 per hundredweight and cull cow price \$.33 less per hundredweight).

^c Cost to put up winter feed not met from this return.

to gain .85 pounds per day. The winter feeding period was assumed as given in Column (4) of Table 47. In all areas it was assumed that the calves would be sold as feeder yearlings off pasture in mid-October. The average October price for feeder cattle in Calgary (\$18.42 per hundred) was used in all regions but the Black and Grey Wooded zones. The average October price in Edmonton (\$16.92 per hundred) was used in these latter two zones. The prices were averages over the 1946-65 period at both points.

The total cost of raising a calf to a feeder yearling less the cost of producing the necessary forage was determined from a budget analysis (Appendix F). The gross return less the total cost as determined above leaves the return to meet forage production costs. These returns varied from \$11.83 per head in the Black and Grey Wooded Regions to \$32.25 in the Southeast (Table 49).

In the matrix the raising of a regionally produced calf to a feeder yearling did not appear as a separate activity. Instead, production of a calf and raising it to a yearling appeared as one operation. The costs and returns for the combined program were the sum of those for the cow calf plus those for the raising of a regional calf to a feeder yearling when the latter were adjusted to a per cow basis by accounting for the percentage calf crop, death loss, and heifers held as replacements (Table 50).

The possibility of buying calves from other regions to raise to yearlings was considered. The returns changed because the initial cost of the calf to all regions increased (Table 51). The cost per hundredweight of the calves to any region was the average price of calves in the other

TABLE 49

COSTS AND RETURNS OF RAISING REGIONAL CALF TO FEEDER YEARLING

	Southeast	Irrigation	Foothills and Northern Prairie	Black and Grey Wooded
	(Per head)			
Cost of calf	\$79.42	\$79.42	\$79.42	\$73.80
Cost to raise to feeder yearling excluding winter forage and pasture charge ^a	28.01	32.17	34.85	39.59
Total cost excluding winter forage and pasture charge ^a	107.43	111.59	114.27	113.39
Gross return	139.68	139.68	137.84	125.22
Net return to meet cost of pasture and winter forage	32.25	28.09	23.57	11.83

^a Cost includes the cost to put up the forage but not the cost of the forage itself.

TABLE 50

COSTS AND RETURNS OF PRODUCING CALVES AND RAISING THEM TO FEEDER YEARLINGS

	Southeast	Irrigation	Foothills	Northern Prairie	Black	Grey Wooded
	(Per cow)					
Cost per cow less pasture and winter forage	\$50.94	\$52.67	\$49.53	\$54.35	\$59.24	\$56.91
Cost to raise a portion of calf to yearling less pasture and winter forage	21.60	21.30	28.10	28.50	30.90	28.80
Total cost less forage	72.54	73.97	77.63	82.85	90.14	85.71
Gross returns per cow with observed calf crop and estimated costs ^a	107.66	92.56	107.06	108.46	101.62	94.96
Returns to meet pasture and winter forage charge						
if calf crop and costs as estimated	35.12	14.59	29.43	25.61	11.48	9.25
if calf crop as observed costs 10 percent lower	42.37	21.99	37.19	33.90	20.49	17.82
if price of steer calves at Edmonton is 25¢ per lb.	57.06	37.53	57.48	48.60	31.61	27.89
if 85 percent calf crop, costs as estimated	55.97	54.54	49.43	44.21	29.07	33.50
if 85 percent calf crop, costs 10 percent lower	63.22	61.94	57.19	52.50	38.08	42.07
if 85 percent calf crop, costs 10 percent lower and price for steer calves at Edmonton is 25¢ per lb.	83.22	81.94	76.89	72.19	57.13	61.12

^a Value of cull cow and yearling less value of heifer for replacement (at 16% replacement rate) and allowing for a three percent death loss.

TABLE 51

COSTS AND RETURNS OF RAISING A CALF PURCHASED FROM ANOTHER REGION TO A FEEDER YEARLING

	Southeast	Irrigation	Foothills and Northern Prairie	Black and Grey Wooded
Cost of calf	\$82.26	\$82.26	\$82.26	\$83.41
Cost to raise to feeder yearling excluding pasture and winter forage ^a	28.01	32.17	34.85	39.59
Total cost excluding pasture and winter forage ^a	110.27	115.03	117.11	123.00
Gross return	139.68	139.68	137.84	125.22
Return to meet cost of pasture and winter forage using estimated costs	29.41	24.65	20.73	2.22
Return to meet pasture and winter forage charge if price of steer calves at Edmonton is 25¢/lb.	38.70	34.54	29.56	13.43
Return to meet pasture and winter feed charge if price for steer calves at Edmonton is 25¢/lb. and costs are 10% lower	41.50	37.76	33.05	17.39

^a Cost includes the cost of putting up winter forage but no charge for the forage itself.

five regions. In addition, a \$5.00 per head charge was levied to cover transportation and other costs associated with the purchase and movement of cattle from outside the region. This cost resulted in lower returns than those formerly determined for this type of operation. The Black and Grey Wooded Regions were more affected than the other regions since they were required to pay a higher average price and the \$5.00 per head charge, while the other areas obtain a lower average purchase price which partially offset the transportation and handling charges.

Animal Unit Months of Feed Required

The animal unit months of forage required per cow for the cow calf operations of the province was about 13 (Table 52). The cow requires 12 AUM. The remainder was calculated as 25 percent of the calf crop times five months, which accounts for the needs of the calf.

The summer requirements for the young stock were slightly less in the Black and Grey Wooded Regions since the cattle are wintered longer than in the other regions. In this case the division between grazing and winter feed was based upon winter feeding periods of 130 days, 165 days, and 184 days in the Southeast and Irrigation, Foothills and Northern Prairie, and the Black and Grey Wooded Regions, respectively.

The Acreage to Improve and Develop

The acreage of privately owned land upon which improvement or development could be made was estimated from survey data (Table 53). The sum of acreages for each practice was greater than the total acreage to be improved because more than one improvement could be applied to any acreage.

The practices selected were those which represent the bulk of the improvement possible and for which coefficients representing the

TABLE 52

ANIMAL UNIT MONTHS OF FORAGE REQUIRED FOR SELECTED BEEF OPERATIONS

	Northern				Grey	
	Southeast	Irrigation	Foothills	Prairie	Black	Wooded
<u>Cow calf</u>						
AUM of grazing per cow	9.605	9.466	9.148	8.062	7.119	7.053
AUM of winter feed per cow	3.640	3.640	4.184	5.284	6.213	6.213
Total AUM of forage per cow	<u>13.245</u>	<u>13.106</u>	<u>13.332</u>	<u>13.346</u>	<u>13.332</u>	<u>13.266</u>
(if 85 percent calf crop)	(13.323)	(13.323)	(13.371)	(13.371)	(13.401)	(13.401)
<u>Cow calf-feeder yearling</u>						
AUM of grazing per cow	13.513	12.820	12.623	11.584	10.099	9.830
AUM of winter feed per cow	5.345	4.868	6.254	7.383	8.470	8.315
Total AUM of forage per cow	<u>18.858</u>	<u>17.688</u>	<u>18.877</u>	<u>18.967</u>	<u>18.569</u>	<u>18.145</u>
(if 85 percent calf crop)	(19.100)	(19.100)	(19.123)	(19.123)	(19.010)	(19.010)
<u>Feeder yearling</u>						
AUM of grazing per head	5.04	5.04	4.30	4.30	3.82	3.82
AUM of winter feed per head	1.87	1.87	2.62	2.62	2.93	2.93
Total AUM of forage per head	<u>6.91</u>	<u>6.91</u>	<u>6.92</u>	<u>6.92</u>	<u>6.75</u>	<u>6.75</u>

TABLE 53

ACREAGE OF PRIVATELY OWNED LAND AVAILABLE TO IMPROVE AND DEVELOP¹

	Southeast	Irrigation	Northern			Grey	
			Foothills	Prairie	Black	Wooded	
			(thousands of acres)				
Seed to tame grass	759.7	183.6	410.4	509.6	832.2	1,526.7	
Irrigate	48.2	56.0	--	--	--	--	
Add water facilities	1,147.0	--	186.0	793.7	--	--	
Fertilize irrigated pasture	--	68.5	--	--	--	--	1
Fertilize dryland pasture	--	303.5	122.0	142.0	45.0	229.0	83
Control brush	--	--	29.90	306.0	421.0	65.4	1
Clear, break and seed to pasture	--	--	38.9	134.3	515.5	1,070.9	

¹ Blanks do not indicate zero potential for that practice within a region but rather that the potential acreage was relatively insignificant compared to other possible practices. To conserve space in the linear programming matrix practices of minor importance were omitted.

improvement in grazing and the cost of improvement were available or were determined. Seven practices were considered with most being represented in several areas.

Linear Programming Solutions of the Provincial Matrices

From the data collected, an initial matrix was established (Matrix A, see Figure III). The assumptions for this matrix were:

- (1) Regional calf crops as observed from the survey data;
- (2) The cost of raising cattle as estimated from the various sources noted previously;
- (3) The returns determined from the average price of cattle over the 20 year period, 1946-1965;
- (4) The annual cost of pasture improvement and development practices included an interest charge at five percent;
- (5) The forage produced was a grass mixture;
- (6) The improvement and development programs were only applied to privately owned land.

Modification of these assumptions produced six variations of Matrix A, Matrices B to G. Profit maximization was the objective of each solution.

Solution of Matrices A and C

Under the assumptions for Matrix A, increases in beef production would occur in four regions--Southeast, Irrigation, Foothills, and Northern Prairie (Table 54). The increase of 76,600 feeder cattle was small, about

TABLE 54

SOLUTION TO MATRICES A¹ AND C²

Region	Forage Production (thousands of acres)				Clear Break Seed	Cow Calf (no. of cows)	Beef Production (thousands of head)		Profit ('000)
	Reseed	Develop Water Facilities	Ferti- lize	Brush Control			Cow to Yearling (no. of cows)	Calf Raised to Yearling (no. heads purchased)	
Southeast	759.7	1147.0				21.0	50.0		\$1,436.
Irrigation	183.6						29.0		620.
Foothills	410.4	186.0		299.0		37.2			180.
Northern Prairie	509.6	793.7				38.3			191.
Total	1863.3	2126.7		299.0		96.5	79.0		2,427
									(76.6) ^a

Output of Feeder Cattle - 76,600 feeder yearlings
 Total Initial Outlay for Improvement and Development Program - \$14,328,691.00
 Total Annual Cost for Improvement and Development Program 2,077,320.00

¹ Assumptions for Matrix A include: observed calf crops, estimated costs of beef operations, returns based on 20 year average prices, improvement costs include interest charge and the forage produced was a grass mixture.

² Assumptions for Matrix C are as for Matrix A except that a grass-legume mixture was assumed to be the forage produced.

^a Number of feeder cattle from each type of production moving to feedlots.

an 8.4 percent increase over the number of cattle produced in 1961.¹ The total initial outlay required for the necessary improvement and development was estimated to be slightly over \$14.3 million. The annual cost would be about \$2.1 million. The profit, over and above all costs, would be about \$2.5 million annually.

Reseeding occurred in all regions which entered the solution. New watering facilities were not added in the Irrigation Region but were developed in the other three. Only in the Foothills was any pasture improved by using brush control techniques.

Matrix C was identical to Matrix A other than a grass-legume mixture was assumed to be the type of forage, rather than a pure grass mixture. The solution was the same as for Matrix A. This indicated that at this level of development there was no advantage of using one type of forage rather than the other.

Solution to Matrix B

Other than assuming an 85 percent calf crop for all regions, Matrix B was like Matrix A. The larger calf crop allowed cattle production to expand in the two most northern regions as well as elsewhere in the province (Table 55). The increased production (186,400 head) was about 20 percent above the 1961 level.

Almost 99,000 feeders were raised within the region where they were born. The remaining 87,500 were born in the Foothills, Black or

¹ Noting from the Census of Agriculture for Alberta that there were approximately 913,000 head of cattle under one year of age in 1961, this figure was assumed to represent the number of cattle produced in that year. Dominion Bureau of Statistics, 1961 Census of Canada Agriculture, Alberta, Bulletin 5.3-3, Table 19.

TABLE 55

SOLUTION TO MATRIX B¹

Region	Forage Production (thousands of acres)			Beef Production (thousands of head)			Profit (¹ 000)
	Reseed	Develop Water Facilities	Ferti- lize Brush Control	Clear Break Seed	Cow Calf (no. of cows)	Cow to Yearling (no. of cows) (no. heads purchased)	
Southeast	759.7	1147.0				90.2	\$2,137.
Irrigation	183.6				10.5		477.
Foothills	410.4	186.0	299.0		37.1		268.
Northern Prairie	509.6	793.7			26.7		505.
Black	832.2				57.2		0
Grey Wooded	1526.7		65.4		11.9		781.
Total	4222.2	2126.7	364.4		106.2	90.2	4,168
					(98.9) ^a	(87.5) ^a	

Output of Feeder Cattle - 186,400 head.

Total Initial Outlay for Improvement and Development Program - \$36,647,896.00

Total Annual Cost for Improvement and Development Program 5,107,402.00

¹ Matrix B assumes an 85% calf crop, otherwise the assumptions are the same as for Matrix A.

^a The number of feeder cattle from each type of production moving to feedlots.

Grey Wooded Regions but raised to yearlings in the Southeast.

The initial outlay and the annual cost more than doubled and profits resulting from the extension of production increased from \$2.4 million to \$4.2 million.

Profits existed for all but the Black Region. This solution indicated that the Black Region was producing calves at a loss which were raised to yearlings in the Southeast. At this level of output the profits of the southeast at least compensated for the losses of the Black Region when provincial profit was considered.

Reseeding of grassland occurred in all regions for a total of 4.22 million acres. Additional watering facilities were developed in three regions--the Southeast, the Foothills and the Northern Prairie. The control of brush to improve or develop pasture was used in the Foothills and Grey Wooded district.

Solution of Matrix D

For Matrix D the costs of beef production other than the forage charge were reduced 10 percent. Otherwise the assumptions were unchanged from those of Matrix A. The solution of Matrix D was similar to that of Matrix A. Increased cattle production was only nominally above that obtained in the solution of Matrix A (Table 56). The initial outlay, annual costs, and resulting profit were also slightly greater. The improvement practices used were the same except that in the solution of Matrix D, brush control was used in the Northern Prairie.

Solution of Matrix E

No interest charge was included in the improvement and development costs used in Matrix E. Again the solution was similar to that

TABLE 56

SOLUTION FOR MATRIX D¹

Region	Forage Production (thousands of acres)				Beef Production (thousands of head)				Profit ('000)
	Reseed	Develop Water Facilities	Ferti- lize	Brush Control	Clear Break Seed	Cow Calf (no. of cows)	Cow to Yearling (no. of cows)	Purchased Calf Raised to Yearling (no.heads purchased)	
Southeast	759.7	1147.0				19.1		53.6	\$1,596.
Irrigation	183.6							29.0	620.
Foothills	410.4	186.0		299.0		37.2			364.
Northern Prairie	<u>509.6</u>	<u>793.7</u>		<u>306.0</u>		<u>44.5</u>			<u>334.</u>
Total	1863.3	2126.7		605.0		100.8		82.6	2,914.
								(80.1) ^a	
Output of Feeder Cattle - 80,100 feeder yearlings.									
Total Initial Outlay for Improvement and Development - \$15,852,574.00									
Total Annual Cost for Improvement and Development - 2,295,498.00									

¹ Assumptions for Matrix D are as for Matrix A except that the cost of production excluding forage charges of the beef enterprises are reduced 10 percent.

^a The number of feeder cattle from each type of activity moving to feedlots.

obtained for Matrix A. Cattle production, initial investment and total profit rose while the annual cost of the program declined modestly (Table 57). The lower cost of improvement allowed the adoption of brush control in the Northern Prairie, and clearing and seeding land for pasture in the Foothills.

Solution of Matrix F

Cattle prices based upon the price of steer calves at Edmonton being \$.25 per pound were used to determine the returns to the beef production activities in Matrix F. The other assumptions of Matrix A were unchanged.

The solution to this problem generated an increase of cattle production of approximately 45 percent above the 1961 level, an increase of over 405,000 head annually (Table 58). Cow numbers increased in the Foothills, the Black Region and most remarkably, in the Grey Wooded district. The calves produced in these regions largely went to other districts (Southeast, Irrigation, Northern Prairie and some to the Foothills) where they were raised to yearlings.

All regions reseeded to improve production. More watering facilities were added as in previous solutions. Fertilizer was applied to dryland pastures in the Irrigation district and to pastures in the Northern Prairie. The use of brush control occurred in all areas except the Southeast and Irrigation Regions.

The initial outlay required by the development and improvement program was in excess of \$53 million. The total annual cost was \$18.7 million. All regions showed a profit, although that of the Grey Wooded Region was small. The total profit for the province was over \$10 million.

TABLE 57

SOLUTION TO MATRIX E¹

Region	Forage Production (thousands of acres)				Beef Production (thousands of head)			
	Reseed	Develop Water Facilities	Ferti- lize	Brush Control	Clear Break Seed	Cow Calf (no. of cows)	Cow to Yearling (no. of cows)	Purchased Calf Raised to Yearling (no. heads purchased) ('000)
Southeast	759.7	1147.0				18.0	55.7	\$1,688.
Irrigation	183.6						29.0	851.
Foothills	410.4	186.0		299.0	38.9	40.8		348.
Northern Prairie	<u>509.6</u>	<u>793.7</u>		<u>306.0</u>		<u>44.5</u>		<u>313.</u>
Total	1863.3	2126.7		605.0	38.9	103.3	84.7	3,000.
							(82.1) ^a	
Output of Feeder Cattle - 82,100 feeder yearlings.								
Total Initial Outlay for Improvement and Development Program - \$17,448,639.00								
Total Annual Cost of Improvement and Development Program 1,838,644.00								

¹ Assumptions are as in Matrix A except the interest charge on the costs of improvement and development practices is excluded.

^a The number of feeder cattle from each type of production moving to feedlots.

TABLE 58

SOLUTION TO MATRIX F¹

Region	Forage Production (thousands of acres)				Beef Production (thousands of head)				Profit ('000)
	Reseed	Develop Water Facilities	Ferti- lize	Brush Control	Clear Break Seed	Cow Calf (no. of cows)	Cow to Yearling (no. of cows)	Purchased Calf Raised to Yearling (no. heads purchased)	
Southeast	759.7	1147.0						90.2	\$2,975.
Irrigation	183.6		303.5 ^a					80.9	1,423.
Foothills	410.4	186.0		299.0		11.5		49.5	2,667.
Northern Prairie	509.6	793.7	651.6	306.0				197.3	2,193.
Black	832.2			421.0		81.3			811.
Grey Wooded	1526.7			65.4		463.4			81.
Total	4222.2	2126.7	2710.8	1091.4		556.2		417.9 (405.4) ^b	10,150

Output of Feeder Cattle - 405, 400 feeder yearlings.

Total Initial Outlay for Improvement and Development Program - \$53,383,852.

Total Annual Cost of Improvement and Development Program 18,741,249.

¹ Returns in Matrix F are based upon cattle prices when the price of steer calves in Edmonton is 25¢ per pound, otherwise the assumptions are in Matrix A.

^a This is dryland which is fertilized.

^b The number of feeder cattle from each type of activity moving to feedlots.

Solution of Matrix G

The assumptions of Matrix G were the most favorable used in this analysis for increasing cattle production. An 85 percent calf crop was assumed for all regions. The costs of the beef production activities (excluding any charge for forage) were 10 percent less than those estimated, and returns were based upon the price of steer calves in Edmonton being \$.25 per pound. Interest charges were excluded from the improvement and development costs. The assumption that the forage would be a grass mixture was unchanged.

The optimum solution of this program produced over 700,000 feeder cattle, an increase of approximately 77 percent above the 1961 level of production (Table 59). Beef cow herds producing stocker calves increased in the Foothills and Grey Wooded Regions. This latter region and the Black Region raised more cattle to be sold as yearlings than previously. The other three districts (Southeast, Irrigation, and Northern Prairie) expanded operations which purchased calves from other areas to raise to feeder yearlings.

Under the more optimistic limits or restrictions much activity was generated on large acreages. The reseeding of pastures increased forage production in all regions. Additional watering facilities improved pasture use in the Southeast, Foothills, and Northern Prairie districts. Fertilization of pasture proved an important method of increasing forage yields in four regions, particularly the Grey Wooded districts. Brush control was utilized in all but the two most southern regions. The clearing and seeding of land for pasture was adopted extensively in this solution. This latter practice was in part due to the fact that interest charges were excluded

TABLE 59

SOLUTION TO MATRIX G¹

Region	Forage Production (thousands of acres)				Beef Production (thousands of head)					Profit ('000)
	Reseed	Develop Water Facilities	Ferti- lize	Brush Control	Clear Break Seed	Cow Calf (no. of cows)	Cow to Yearling (no. of cows)	Purchased		
								Calf Raised to Yearling	(no.heads purchased)	
Southeast	759.7	1147.0						90.2		\$3,380.
Irrigation	183.6		303.5 ^a					80.9		1,715.
Foothills	410.7	186.0	532.4	299.0	38.9	90.3				1,039.
Northern Prairie	509.6	793.7	651.6	306.0	134.3			216.8		3,364.
Black	832.2			421.0	515.5		105.3			3,574.
Grey Wooded	1526.7		2826.6	65.4	1070.9	366.2	294.7			13,016.
Total	4222.2	2126.7	4314.0	1091.4	1759.6	456.5	400.0	387.9	(376.3) ^b	26,088.

Output of Feeder Cattle - 706,300

Total Initial Outlay for Improvement and Development Program - \$140,901,579.00

Total Annual Cost of Improvement and Development Program 30,215,673.00

¹ Matrix G assumes an 85 percent calf crop, costs of beef operations (including the forage charge) is 10 percent less than estimated, returns are based on the price of steer calves in Edmonton being 25¢ per pound and the cost of the improvement activities excluded any charge for interest. As in Matrix A the forage was assumed to be a grass mixture.

^a This is dryland pasture which is fertilized.

^b The number of feeder cattle from each type of production moving to feedlots.

from the costs of improvement and development practices.

The initial outlay required for the improvement and development of grasslands to support the expanded cattle population exceeded \$140 million. The annual cost associated with such a development was a little more than \$30 million. An annual profit of \$26 million resulted under these assumptions, of which one half occurred in the Grey Wooded Region.

Summary

Under the conditions stipulated by current costs, observed calf crops and 20 year average prices, only modest expansion of the cattle population appeared profitable. Higher calf crops and moderately higher prices greatly enhanced the possibility of continued increases in cattle production, particularly in the two most northern regions of the province.

Reseeding pastures and hayland to tame grass appeared as one of the most likely methods for use to increase grassland productivity. Adding more watering facilities and the controlling of brush were profitable in most cases. Fertilization of grassland occurred only in the two programs using the higher cattle prices. Clearing, breaking, and seeding land to pasture entered the solution when interest charges were excluded from improvement and development costs.

Annual profits were usually greatest for the Southeast district. Only in the Matrix G did the profits of any region exceed those of the Southeast. In this case the profits of the Black Region were slightly greater but those of the Grey Wooded area were vastly superior due to the considerable increase in that region's cattle operations under the conditions assumed.

Predicted Beef Cattle Population of Alberta - 1980

By 1980 there will be 1.75 million beef cows in Alberta. This prediction is based upon the expected increases in Canadian cattle numbers, and the observed rate of increase of Alberta's beef cow population.

The possibility of such an expansion is based on the solutions to Matrices F and G between which the assumptions of the true situation likely rests.¹ The exact solutions are normative and are expected to be only partially achieved because the true restrictions will differ from those assumed. Nevertheless, we may speculate that they do provide an insight to the direction of movements in the primary production of beef.

Regionally, too many factors must be considered to allow the detailed prediction of interregional shifts in the cattle population from the data available here. However, it appears that, of necessity, relatively more of the primary production of beef will occur in the central and northern sectors of agricultural Alberta.

The above prediction, like most projections into the future, is subject to many influencing factors and new elements which may arise unexpectedly. Based upon this study it is limited by present knowledge and the techniques used. Subject to these limitations represents the author's best estimate.

Solutions of the Individual Regional Matrices

In addition to solving the provincial matrices, the solution of each regional matrix in isolation from the rest of the province was obtained. These solutions were based upon the initial assumptions outlined

¹ Also some improvement may be expected to provide additional forage from public lands. This is studied in a separate project.

for the provincial analysis except that returns were based upon cattle prices when steer calves in Edmonton sold for \$.25 per pound. The results are given in Table 60.

Reseeding occurred in all regions. Additional watering facilities were provided in the Southeast, Foothills and Northern Prairie while brush control increased output in the Foothills, Northern Prairie, Black and Grey Wooded Regions. In no region was irrigation, fertilization or clearing, breaking and seeding used to improve or increase grassland.

Only two beef production activities were considered--a cow operation selling stocker calves and a cow operation selling feeder yearlings. Cow calf operations developed in all regions but the Irrigation district.

The initial outlay for the development and improvement programs varied from \$.89 million to \$14.9 million. The annual cost of the program was lowest in the Irrigation district as were the profits. The Grey Wooded Region displayed the highest annual cost, almost \$2 million. The greatest profits, \$1.4 million, occurred in the Southeast.

Returns per Farm Resulting from Matrix Solutions

A summary of annual costs and net returns on a per farm basis for the province is given for the solutions for Matrices B, F, and G (Table 61). When examined on a per farm basis the cost and return relationships suggest that a substantial improvement of grazing capacity is feasible on the private grazing land.

Development is not likely to occur at equal rates on the farms and ranches of each of the six regions examined. When net returns are

TABLE 60

SOLUTIONS OF REGIONAL MATRICES¹

Region	Forage Production (thousands of acres)				Beef Production (thousands of head)					
	Reseed	Develop Water Facilities	Ferti- lize	Brush Control	Clear Brush Reseed	Cow Calf	Cow to Yearling	Initial Outlay	Annual Cost	Annual Profit
Southeast	759.7	1,147.0				47.1 (37.1) ^a		\$4,721.	\$ 517.	\$1,397.
Irrigation	183.6						11.3	889.	94.	330.
Foothills	410.4	186.0		299.0		37.2 (30.5)		4,486.	788.	852.
Northern Prairie	510.6	793.7		306.0		44.5 (37.0)		5,757.	896.	898.
Black	832.2			421.0		81.5 (64.7)		9,495.	1,355.	812.
Grey Wooded	1,526.7			65.4		121.0 (89.8)		14,921.	1,975.	939.

¹ Each regional matrix was solved using the assumption of Matrix F of the provincial linear programming analysis.

^a The output of feeder stock (in thousands) from the beef production operations is shown by the bracketed figures.

TABLE 61

ANNUAL COSTS AND NET RETURNS PER FARM - PROVINCE

Matrix	B	F	G
	(dollars)		
Costs	77.9	285	458
Net Returns ^a	62.5	155	392

^a Returns after all costs are met.

TABLE 62

ANNUAL NET RETURNS PER FARM FROM PASTURE IMPROVEMENT BY REGIONS

Region/Matrix	B	F	G
	(dollars)		
Southeast	189	264	300
Irrigated	254	760	915
Foothills	45.5	454	177
Northern Prairies	56.4	244	325
Black Soil	-	85	377
Grey Wooded	66.6	6.9	1,110

examined on a regional basis the solutions for Matrices B, F, and G provide useful guides based on probable annual net returns per farm. It is significant that only under the conditions assumed in Matrices F and G would farm in the Black and Grey Wooded Regions respectively enter into improvement programs (Table 62).

CHAPTER V

SUMMARY AND CONCLUSIONS

A rising demand for beef is expected to cause cattle numbers in Canada to increase more than 50 percent by 1980. These cattle will require the equivalent of an additional eleven million acres of improved grassland.

Since about 40 percent of Canada's cow population is in Alberta the upward trend in beef cattle numbers will significantly affect this province. The problems considered were (1) what constituted the current grazing resources of Alberta, (2) what potential existed for the expansion of such resources, and (3) where within the province would the expansion of the cattle population take place.

A survey of 1610 randomly selected farm operators in the province (which yielded 1371 usable responses) provided an assessment of current grazing resources and potential grazing lands. It revealed that excluding the acreage of public land pastured by more than one operator and paid for by a per head charge, there were 19.3 million acres of land used solely for pasture, of which 85 percent was unimproved native forage. Despite the large acreage, unimproved native pastureland provided only about 60 percent of the total grazing while the relatively small proportion of tame pastureland produced over 18 percent. Crop residues provided over 12 percent of the total grazing.

Regionally, native pastures were more important in the southeastern region of the province. Yet native pastures provided more than one half of the grazing in all regions. In the three most northern regions, which

provided 44 percent of the total grazing, tame pastures and crop residue were more important than elsewhere.

Eighty percent of the 13.4 million animal unit months of grazing came from privately owned land. Pasture leased from the public domain provided the remaining 20 percent but occupied 44 percent of the pastureland.

A comparison of public and private rental rates indicated that the charge per animal unit month of grazing was substantially lower on public lands. The public lands were leased for much longer periods than private lands.

Seventy percent of the farms reported 11.4 million acres of pasture which could be improved to provide more grazing. No allowance was made in this estimate for duplication of more than one improvement practice on an acre. The most frequently cited improvements included clearing land, control of bush, reseeding, fertilization, and additional watering facilities. A total of 1.67 million acres of privately owned land was available to develop for grassland. Sixty-five percent of this acreage was found in the three most northern regions of the province (Regions VI, VII, and VIII).

Besides the data concerning the cost of improvement and development practices obtained from the survey of the 1371 farms, additional information was secured from a mail questionnaire sent to farmers known to have employed improvement practices. Replies were received from 367 individuals. This source of data substantially improved cost estimates. Ninety-five percent of this group felt the practices which they had employed

proved profitable. Their chief sources of information concerning type of improvement, costs, and response were the district agriculturists, farm magazines and government research stations.

The primary factors which hindered further improvement or development of land for pasture were better uses for limited capital, lack of time and restricted credit. Only in the two most southern regions was risk considered a major factor restricting improvement. Those who had made improvements appeared relatively unrestricted by credit limitations, had 10 to 30 years of farming experience and a higher level of total sales than those not improving pasture. Both groups had the same potential acreage to improve.

Utilizing survey data as much as possible and drawing upon supplementary sources where necessary, the coefficients required for the linear programming analysis were determined. Matrices were designed to allow interregional competition among six regions for increase in the production of forage and feeder cattle which would arise under profit maximizing conditions. Various price, costs, and production assumptions were made which resulted in seven different matrices and solutions.

Significant increases in cattle production arising from the improvement or development of privately owned land would occur only if prices were moderately above the twenty year average or if improved management practices produced a higher percentage calf crop. The improvement of the percentage calf crop seemed not only possible but necessary if cattle operations in many areas were to be profitable. The reseedling of native pasture and hayland to tame forages appeared to have substantial

potential as a profitable method of generating additional forage production in all regions of Alberta. The existence of a potential for pasture improvement when combined with improved prices and management will contribute to an expansion of the beef cattle population in Alberta to the point that by 1980 there will be approximately 1.75 million beef cows in the province.

APPENDICES

APPENDIX A

TABLE 1

DISTRIBUTION OF CENSUS SAMPLE AS DRAWN BY DOMINION BUREAU OF STATISTICS
AND AS SELECTED FROM THE LIST OF HOMESTEADS ACQUIRED AFTER JULY 1, 1961

Census Division	No. of Clusters	No. in Sample	% of Total Sample	No. Homesteads Acquired July 1, 1961 to July 1, 1963	% of Total Home- steads	No. Homesteads Included in Survey Sample
1	16	64	4.08	1	.048	1
2	35	140	8.93	5	.240	
3	19	76	4.85	2	.096	
4	17	68	4.34	2	.096	
5	32	128	8.36	10	.479	
6	35	140	8.93	7	.336	
7	24	96	6.13	14	.671	
8	8	32	2.04	--	--	
8	24	96	6.12	43	2.061	1
9	1	4	.03	1	.048	
10	47	188	12.00	53	2.541	1
11	38	152	9.70	128	6.136	3
12	20	80	5.10	46	2.205	1
13	33	132	8.42	87	4.171	2
14	4	16	1.02	62	2.972	1
15	39	156	9.95	1625	77,900	32
Total	392	1568	100.0	2086	100.0	42

TABLE 2

RESPONSE TO THE SURVEY

Census Division	No. in Sample	Refusals	Transfer & Consolidation	Farm Shrinkage	Other	Total Ineligible (Unusable)	Net Usable Questionnaires
1	65	--	4	--	--	4	4
2	140	6	7	5	5	23	117
3	76	2	5	2	2	11	65
4	68	4	6	1	--	11	57
5	128	10	6	1	6	23	105
6	140	3	6	5	4	18	122
7	96	1	5	2	2	10	86
8 (1/30) ^a	32	--	3	1	--	4	28
8 (1/50)	97	5	3	--	2	10	87
8 (total) (129)		(5)	(6)	(1)	(1)	(14)	(116)
9	4	--	1	--	--	1	3
10	189	7	7	5	5	24	165
11	155	9	4	2	8	23	132
12	81	3	4	1	4	12	69
13	134	4	10	3	7	24	110
14	17	1	1	1	2	5	12
15	188	3	7	5	21	36	152
Total	1,610	58	79	34	68	239	1,371
Percent of Total		3.6%	4.9%	2.1%	4.2%	14.8%	85.2%

^a Part of Census Division No. 8 was sampled at the 1/30 rate and part at the 1/50 rate.

TABLE 3

COST QUESTIONNAIRE - DISTRIBUTION OF SAMPLE AND RESPONSE

Census Division	Questionnaires Sent		Questionnaires Received		Usable Questionnaires		Unusable Questionnaires	
	No.	% of Total	No.	% of Sent	No.	% of Sent	No.	% of Received
1	20	3.9	13	65	12	60.0	1	7.7
2	38	7.4	29	76.3	23	60.5	6	20.7
3.	20	3.9	15	76	8	40.0	7	46.7
4	34	6.6	25	73.5	22	64.7	3	12.0
5	29	5.7	22	75.9	18	62.1	4	18.2
6	43	8.4	33	76.7	29	67.4	4	12.1
7	32	6.3	24	75.0	19	59.4	5	20.8
8	80	15.6	59	73.8	51	63.8	8	13.6
10	54	10.5	33	61.1	29	53.7	4	12.1
11	24	4.7	19	79.2	18	75.0	1	5.3
12	53	10.4	29	54.7	25	47.2	4	13.8
13	53	10.4	35	66.0	30	56.6	5	14.3
14	6	1.2	5	83.3	5	83.3	-	-
15	26	5.0	16	61.5	12	46.2	4	25
Total	512	100.0	357	69.7	301	58.79	56	15.69

TABLE 4

EXPANSION FACTORS BY CENSUS DISTRICTS AND BY REGIONS

Census Division	Expansion Factor	Grazing Region	Expansion Factor
1	30.625	I	33.178
2	34.928	II	37.279
3	34.130	III	34.276
4	34.823	IV	33.841
5	35.584	V	46.177
6	33.497	VI	55.871
7	54.307	VII	57.065
8 (less I.D. 65 & 68)	54.242	VIII	60.457
9 (less I.D. 65 & 68)	33.924		
10	55.735		
11	57.157		
12	57.130		
13	59.289		
14	69.033		
15	60.457		

TABLE 5

COMPARISON OF 1961 CENSUS DATA WITH 1965 SURVEY ESTIMATES

Census Division	No. of ^a Farms	Total Farm Acres ('000)	Difference in Total Acres of % of 1961
1 Census	2165	4222	
Estimate	1898	4468	+5.83
2 Census	4735	4043	
Estimate	4087	3234	-20.00
3 Census	2646	2951	
Estimate	2218	1966	-33.37
4 Census	2126	4936	
Estimate	1985	5002	+1.33
5 Census	4333	3939	
Estimate	3736	4070	+3.32
6 Census	4838	3057	
Estimate	4087	3541	+15.83
7 Census	5199	4434	
Estimate	4670	4450	+ .36
8 Less I.D. 65 & 68			
Census	7515	2239	
Estimate	4719	2005	-10.45
9 Plus I.D. 65 & 68			
Census	1211	676	
Estimate	1052	445	-34.17
10 Census	10,188	4820	
Estimate	9196	4001	-4.54
11 Census	8512	2618	
Estimate	7545	2871	+9.66
12 Census	4494	1868	
Estimate	3942	1985	-6.26
13 Census	7322	2723	
Estimate	6522	2974	+9.22
14 Census	973	360	
Estimate	828	462	+28.33
15 Census	8955	4341	
Estimate	9189	5747	+32.39
Province Census	73,212	47,229	
Estimate	65,674	47,821	+1.25

^a Number of farms in the Census equals the number of operators but in the estimates one farm may have more than one operator (i.e., partnership), hence the estimates are lower in part due to this fact.

TABLE 6

COMPARISON OF REGIONAL ESTIMATES OF FARM ACREAGE WITH CENSUS DATA

Region	Total Farm Acreage Census ^a ('000)	Estimated ('000)	Difference as a % of Census Figure
I	9158 ^b	8255	-9.86
II	--	3012	--
III	--	1873	--
IV	6008 ^b	5867	-2.35
V	8373 ^b	8959	+7.00
VI	9677	9485	-1.98
VII	5627	5976	+6.20
VIII	4341	5747	+32.39

^a Calculated from Census of Canada, Bulletin 5.3-3, (1961).

^b Approximate values estimated from census data.

TABLE 7

REGIONAL STATISTICS COMPARING FARM ACREAGES, INCOME AND LIVESTOCK NUMBERS

	I	II	III	IV	V	VI	VII	VIII
<u>Acres in farm</u>								
Owned & operated	770.6	651.1	509.3	628.7	681.9	349.0	368.9	482.8
Rented	115.4	199.5	74.0	180.1	262.1	78.8	52.9	48.4
Leased	1,375.8	122.9	509.6	143.8	87.6	14.2	50.0	94.3
Total	2,261.8	973.5	1,092.9	952.6	1,032.0	442.1	471.7	625.5
<u>Acres of Pasture</u>	1,700	341.2	767.5	590.3	446.6	222.8	233.8	206.6
<u>Income from sale of</u>								
Grain & forage (\$)	5,605.8	8,188.9	4,489.6	4,687.0	9,173.0	2,446.0	1,504.7	3,711.2
Livestock	4,297.2	5,057.4	8,552.8	11,031.2	4,890.0	4,719.3	2,843.0	1,133.7
Total	9,903.0	13,246.3	13,042.4	15,718.2	14,063.0	7,165.3	4,347.7	4,844.9
<u>Stock</u>								
Total cattle on farm	74.0	50.0	118.0	93.1	56.4	39.3	32.0	16.3
Beef cows	42.3	25.9	45.5	42.1	27.0	14.5	14.4	8.4
Dairy cows	2.2	1.0	4.8	4.2	3.1	5.9	4.5	1.3
Calves, yearlings and two year olds sold	30.0	28.9	32.8	50.7	23.7	16.5	10.6	4.3
Sheep on farm	15.7	1.2	19.2	6.9	.13	1.1	1.6	.02
Hogs sold	8.7	10.3	31.8	30.7	25.4	41.7	33.1	14.6

TABLE 8

ESTIMATED ACREAGE OF AND GRAZING FROM PUBLIC LANDS IN GRAZING RESERVES
AND COMMUNITY PASTURES¹

Census District	Estimated Acreage ('000)	Estimated AUM of Grazing ('000)
1	322.8	92.0
2	381.4	106.8
3	262.4	104.6
4	--	41.9
5	68.1	1.7
6	197.0	61.1
7	--	69.1
.	.	.
.	.	.
.	.	.
15	.	.
Province	1,231.7	477.2

¹ No estimate was made if there were less than three observations.

TABLE 9

REGIONAL DISTRIBUTION OF AUM OF GRAZING BY PASTURE TYPE AND LAND TENURE

Region	Tenure	Unimproved Native	Improved Native	Tame	Irrigated Tame	Irrigated Native	Crop Residue	Total
		(thousands)						
I	Owned	268.1	63.7	27.9			65.4	425.1
	Rented	17.9	--	1.1			9.3	28.3
	Leased	1,030.4	113.7	16.1			1.6	1,161.8
	Total	1,316.4	177.4	45.1			76.3	1,615.2
II	Owned	272.3	4.9	136.8			19.7	470.7
	Rented	43.2	1.7	.6			--	45.5
	Leased	130.4	--	--			--	130.4
	Total	445.9	43.6	137.4			19.7	646.6
III	Owned	99.8	--	16.6	269.6	2.7	19.2	407.9
	Rented	7.7	.2	4.9	13.3	3.7	1.7	31.5
	Leased	274.9	--	--	1.1	3.1	--	279.1
	Total	382.4	.2	21.5	284.0	9.5	20.9	718.5
IV	Owned	1,363.2	105.1	268.0			175.3	1,911.5
	Rented	215.9	26.6	39.5			32.2	314.2
	Leased	323.3	--	--			--	323.3
	Total	1,902.4	131.7	307.5			207.5	2,549.0
V	Owned	807.4	81.2	217.5			230.3	1,336.4
	Rented	262.5	34.6	26.0			42.4	365.5
	Leased	219.3	13.4	--			.9	233.6
	Total	1,289.2	129.2	243.5			273.6	1,935.5
VI	Owned	1,155.7	171.9	942.3			597.2	2,867.1
	Rented	337.2	28.6	71.4			37.3	474.5
	Leased	137.6	.7	5.2			.2	143.7
	Total	1,630.5	201.2	1,018.9			634.7	3,485.3

... continued

TABLE 9

(continued)

Region	Tenure	Unimproved Native	Improved Native	Tame	Irrigated Tame	Irrigated Native	Crop Residue	Total
(thousands)								
VII	Owned	527.0	147.2	544.6			315.9	1,534.7
	Rented	87.7	9.7	6.0			9.1	112.5
	Leased	157.3	8.4	9.2			1.3	176.2
	Total	<u>772.0</u>	<u>105.3</u>	<u>559.8</u>			<u>326.3</u>	<u>1,823.4</u>
VIII	Owned	218.4	5.6	137.5			94.3	455.8
	Rented	10.2	--	--			8.5	18.7
	Leased	145.7	8.0	--			--	153.7
	Total	<u>374.3</u>	<u>13.6</u>	<u>137.5</u>			<u>102.8</u>	<u>628.2</u>

TABLE 10

CONDITION OF PASTURE AS CLASSIFIED BY TENURE

	Owned	Rented	Leased
Excellent	6.2	7.7	10.8
Good	28.4	32.3	40.6
Fair	39.9	33.5	37.8
Poor	25.5	26.5	10.8

TABLE 11

THE PERCENTAGE OF PASTURELAND WHICH IS PART OF A CROP ROTATION

Region	% of Pastureland in Crop Rotation
I	.2
II	1.9
III	2.9
IV	1.8
V	2.0
VI	3.7
VII	5.1
VIII	1.4

TABLE 12

FERTILIZER USE ON PASTURE

Region	Farmers Using Fertilizer on Pasture (% of Total in Region)	Percentage of Tame Pastureland Fertilized	Total Cost of Fertilizer Used On Pasture (Per Farm in Dollars)
I	1.8%	.05%	\$ 3.14
II	7.2%	2.0%	45.84
III	34.0%	1.6%	58.40
IV	7.7%	.9%	12.50
V	4.8%	1.3%	12.12
VI	9.9%	3.0%	12.92
VII	9.0%	2.0%	6.70
VIII	1.3%	1.4%	2.80
Average	9.5%	1.5%	19.30

TABLE 13
ACRES OF PASTURE FERTILIZED AND RATE OF USE¹

	Irrigation	Southeast ^d	Northern Prairie	Foothills	Black	Grey Wooded
Acres fertilized per farm	80	--	40	67	39	34
Percent of pasture	2.1	--	42	1.2	14.2	6.9
Pounds of nitrogen per acre	43.8	--	22.7	35.1	37.3	34.9
Pounds of P ₂ O ₅	19.7	--	9.8	10.5	11.0	--
Number of responses	30	2	5	33	111	5

¹ Data from mail questionnaire

^d Insufficient responses

TABLE 14
FREQUENCY OF FERTILIZER APPLICATION OF PASTURE¹

Frequency	Percentage of farmers using this frequency of application
Twice per year	8.2%
Once per year	72.2%
Once in two years	9.4%
Once in three years	4.8%
Other	5.4%

¹ Data from mail questionnaire.

1. The first part of the book is devoted to a general introduction to the subject of the history of the English language.

2. The second part of the book is devoted to a detailed account of the development of the English language from its earliest forms to the present day.

3. The third part of the book is devoted to a study of the influence of foreign languages on the English language.

4. The fourth part of the book is devoted to a study of the influence of the English language on other languages.

5. The fifth part of the book is devoted to a study of the influence of the English language on the culture of other countries.

6. The sixth part of the book is devoted to a study of the influence of the English language on the literature of other countries.

7. The seventh part of the book is devoted to a study of the influence of the English language on the science of other countries.

8. The eighth part of the book is devoted to a study of the influence of the English language on the art of other countries.

9. The ninth part of the book is devoted to a study of the influence of the English language on the philosophy of other countries.

10. The tenth part of the book is devoted to a study of the influence of the English language on the religion of other countries.

11. The eleventh part of the book is devoted to a study of the influence of the English language on the politics of other countries.

12. The twelfth part of the book is devoted to a study of the influence of the English language on the social life of other countries.

Chapter	Page
I. The first part of the book is devoted to a general introduction to the subject of the history of the English language.	1-10
II. The second part of the book is devoted to a detailed account of the development of the English language from its earliest forms to the present day.	11-20
III. The third part of the book is devoted to a study of the influence of foreign languages on the English language.	21-30
IV. The fourth part of the book is devoted to a study of the influence of the English language on other languages.	31-40
V. The fifth part of the book is devoted to a study of the influence of the English language on the culture of other countries.	41-50
VI. The sixth part of the book is devoted to a study of the influence of the English language on the literature of other countries.	51-60
VII. The seventh part of the book is devoted to a study of the influence of the English language on the science of other countries.	61-70
VIII. The eighth part of the book is devoted to a study of the influence of the English language on the art of other countries.	71-80
IX. The ninth part of the book is devoted to a study of the influence of the English language on the philosophy of other countries.	81-90
X. The tenth part of the book is devoted to a study of the influence of the English language on the religion of other countries.	91-100
XI. The eleventh part of the book is devoted to a study of the influence of the English language on the politics of other countries.	101-110
XII. The twelfth part of the book is devoted to a study of the influence of the English language on the social life of other countries.	111-120

TABLE 15

(continued)

Practice	I	II	III	IV	V	VI	VII	VIII	Provincial ^a Average
Fence	--	--	1.25	5.25	--	3.42	3.56	--	3.37
no. of observations	--	--	1	2	--	7	4	--	14
average acreage	--	--	160	74	--	66.4	51.3	--	67.9
Control of weeds	--	1.00	1.50	1.00	2.06	--	--	--	1.09
no. of observations	--	1	1	3	1	--	--	--	6
average acreage	--	4	10	70	16	--	--	--	40

^a The average cost is the average of the regional costs weighted by the total relevant acreage within each region. The average acreage is the average of the regional averages weighted by the number of observations.

TABLE 16

REPORTED COSTS OF DEVELOPING LAND FOR PASTURE - 1964

	I	II	III	IV	V	VI	VII	VIII	Provincial ^a Average
Clear land	--	--	--	8.53	120.00	20.71	16.62	21.37	19.68
No. of observations	--	--	--	1	1	3	5	2	12
Average acreage per observation	--	--	--	80	10	37.7	23.6	40	42.8
Prepare seedbed and seed to tame grass	7.46	4.80	9.37	3.59	2.87	7.59	10.41	8.00	6.06
No. of observations	2	2	3	4	4	5	4	2	26
Average acreage	65	22.5	21	26.7	62.3	50	14.5	40	38.4
Drain	--	--	--	--	--	--	10.00	--	10.00
No. of observations	--	--	--	--	--	--	1	--	1
Average acreage	--	--	--	--	--	--	15	--	15
Fence	--	--	--	4.57	3.75	8.33	.69	8.00	3.50
No. of observations	--	--	--	2	1	2	2	1	8
Average acreage	--	--	--	70	40	20	65	3	49.1

^a The average costs are calculated by weighting each region cost by the total acreage (number of observations x average acreage). The average acreage calculated by weighting the regional averages by the number of observations.

TABLE 17

ESTIMATED COSTS OF DEVELOPING PASTURELAND

Practice	I	II	III	IV	V	VI	VII	Provincial ^a	
								VIII	Average
Clear land	--	--	--	23.55	49.58	30.89	24.27	22.92	27.13
no. of observations	--	--	--	8	4	46	58	24	140
average acreage per observation	--	--	--	99	273	71	111	153	109
Control of brush	--	--	--	--	--	--	--	10.00	10.00
no. of observations	--	--	--	--	--	--	--	1	1
average acreage	--	--	--	--	--	--	--	40	40
Seed bed preparation and seeding to tame areas	4.69	8.10	12.85	7.46	5.83	14.95	15.76	16.74	12.05
no. of observations	10	12	9	20	25	49	50	23	198
average acreage	144	85	106	2.3	108	69	113	168	117.5
Irrigate	60.00	40.15	55.85	--	--	--	--	--	51.18
no. of observations	1	1	1	--	--	--	--	--	3
average acreage	40	230	468	--	--	--	--	--	246
Add water facilities	--	20.00	--	--	1.87	20.00	--	--	7.36
no. of observations	--	1	--	--	2	1	--	--	4
average acreage	--	80	--	--	115	20	--	--	82.5
Fence	3.13	5.00	--	1.63	3.05	3.34	4.40	3.11	3.33
no. of observations	1	1	--	2	4	16	17	13	54
average acreage	160	40	--	2.15	75.5	46.7	68.1	170	93.5
Drain	--	38.57	50.00	64.35	11.67	14.45	8.37	5.09	13.37
no. of observations	--	3	1	3	3	3	6	3	22
average acreage	--	20	10	15	80	79	105	77	66.2

^a The average cost is determined by weighting the cost of each region by the total relevant acreage. The average acreage is calculated by weighting each region average by the number of observations.

TABLE 18

REPORTED COSTS OF PASTURE IMPROVEMENT AND DEVELOPMENT PRACTICES FROM THE MAIL QUESTIONNAIRE¹

	Northern				Provincial	
	Southeast	Irrigation	Prairie	Foothills	Black	Grey
					Wooded	Average
Clear land ^a						
no. of observations	--	--	15.20	25.23	15.76	19.78
average acreage	--	--	7	10	47	40
	--	--	59	167	84	81
Seeding onto cleared land						
no. of observations	--	--	3.11	9.85	4.20	3.07
average acreage	--	--	3	3	13	5
	--	--	60	22	35	24
Break land ^b						
no. of observations	--	--	12.32	13.68	16.23	11.86
average acreage	--	--	3	9	30	33
	--	--	51	122	51	72
Control of brush ^c						
no. of observations	9.03	--	4.87	3.69	4.64	4.06
average acreage	5	--	2	7	11	6
	48	--	15	115	53	135
Seed native pasture to tame grass						
no. of observations	3.29	6.95	5.59	4.39	5.34	6.88
average acreage	5	9	4	6	19	17
	73	94	21	94	28	46
Seed abandoned cropland to tame grass						
no. of observations	5.49	7.91	8.35	6.00	--	5.51
average acreage	29	16	15	8	--	21
	4.3	16	114	143	--	26
Irrigated ^d						
no. of observations	--	34.68	--	49.33	--	--
	--	26	--	2	--	--

¹ The average cost is the average of the regional costs weighted by the relevant total acreage. The average acreages are the average of the regional acreages weighted by the number of observations.

^a 71.4% was bulldozed, 24.6% brush cut, 4% other methods.

^b By disk, 40.2%; plow 41.9%; rotary plow, 6.3%; and other methods, 11.6%.

^c Chemical spray (one third aerial) and mowing

^d 80% flood irrigation.

TABLE 19

FREQUENCY OF FAILURE WHEN SEEDING GRASS¹

	Seed grass on cleared land with no seed bed preparation	Seeding native pasture to tame grass	Seeding abandoned cropland to tame grass
Never	45.8	57.7	41.6
Seldom	41.7	28.8	48.7
Often	12.5	13.5	9.7

¹ Data from mail questionnaire.

TABLE 20

FREQUENCY OF FAILURE WHEN SEEDING GRASS ON CLEARED LAND
WITHOUT SEEDBED PREPARATION¹

Never	Seldom Percent	Often	Number of Observations ^a
47.9	39.1	13.0	23

¹ Data from mail in questionnaire

^a Irrigation and Southeast Regions omitted.

TABLE 21

FREQUENCY OF FAILURE WITHIN REGIONS WHEN SEEDING NATIVE PASTURE TO TAME GRASS¹

	Irriga- tion	South- east	Northern Prairie	Foot- hills	Black	Grey Wooded	Province
Never	37.5	--	75	71.4	66.7	46.7	57.7
Seldom	12.5	--	--	28.6	27.8	46.7	28.8
Often	50	--	25	0	5.5	6.6	13.5
No. of observations	8	0	4	7	18	15	52

¹ Data from mail questionnaire.

TABLE 22

FREQUENCY OF FAILURE WHEN SEEDING ABANDONED CROPLAND TO GRASS¹

	Irriga- tion	South- east	Northern Prairie	Foot- hills	Black	Grey Wooded	Province
Never	25.0	44.8	35.7	44.4	54.4	39.1	41.6
Seldom	62.5	48.3	42.9	65.6	36.4	52.2	48.7
Often	12.5	6.9	21.4	0	9.1	8.7	9.7
No. of observations	16	29	74	9	22	23	17.3

¹ Data from mail questionnaire.

TABLE I

MEAN VALUES OF TOTAL C, ORGANIC C AND INORGANIC C IN SOILS OF DIFFERENT TYPES AND DEPTHS IN THE
FOREST

Depth (cm)	Total C	Organic C	Inorganic C	Soil Type	Forest Type
0-10	1.20	1.10	0.10	Forest Soil	Deciduous
10-20	0.80	0.70	0.10	Forest Soil	Deciduous
20-30	0.50	0.40	0.10	Forest Soil	Deciduous
30-40	0.30	0.20	0.10	Forest Soil	Deciduous
40-50	0.20	0.10	0.10	Forest Soil	Deciduous

Continued on next page

TABLE II

MEAN VALUES OF TOTAL C, ORGANIC C AND INORGANIC C IN SOILS OF DIFFERENT TYPES AND DEPTHS IN THE
FOREST

Depth (cm)	Total C	Organic C	Inorganic C	Soil Type	Forest Type
0-10	1.20	1.10	0.10	Forest Soil	Deciduous
10-20	0.80	0.70	0.10	Forest Soil	Deciduous
20-30	0.50	0.40	0.10	Forest Soil	Deciduous
30-40	0.30	0.20	0.10	Forest Soil	Deciduous
40-50	0.20	0.10	0.10	Forest Soil	Deciduous

Continued on next page

TABLE 23

REASONS FOR NOT DEVELOPING ADDITIONAL LAND FOR PASTURE

Reason	I	II	III	IV	V	VI	VII	VIII	Province
Better use of capital	25	9.1	16.7	24	15.8	27.5	34.8	21.6	24.8
Lack time	25	18.2	25	16	28.9	17.5	16.0	13.5	18.6
Unable to obtain credit	0	22.7	25	12	0	13.0	21.3	8.1	13.4
Too risky	25	4.5	8.3	8	10.5	1.4	1.3	0	4.5
Lack information	8.3	9.1	0	0	0	0	1.3	0	1.4
Fully developed	8.3	0	8.3	4	5.3	2.9	1.3	0	2.8
Other reasons	<u>8.4</u>	<u>36.4</u>	<u>16.7</u>	<u>36</u>	<u>39.5</u>	<u>37.7</u>	<u>24.0</u>	<u>56.8</u>	<u>34.5</u>
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

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TABLE 24

ITEMIZATION OF OTHER REASONS WHY LAND WAS NOT DEVELOPED FOR PASTURE

Reason	Percent
Have sufficient pasture and not interested in more	35.7
Poor weather prevented development	13.8
Unable to obtain permission of neighbor or local gov.	8.4
Limitations due to health and age or impending retirement	7.6
Miscellaneous reasons	<u>34.7</u>
	100.0

TABLE 25

REASONS FOR NOT IMPROVING PASTURE

Reason	I	II	III	IV	V	VI	VII	VIII	Province
Better use of capital	18.9	19.3	31.6	30.4	23.1	32.4	36.8	34.3	30.3
Lack of time	17.0	6.5	10.5	14.1	22.0	11.6	13.2	11.9	13.7
Unable to obtain credit	5.7	16.2	31.6	12.1	6.6	8.3	17.6	1.5	10.5
Too risky	15.1	0	0	3.0	7.7	4.6	1.5	0	4.2
Lack information	7.5	3.2	0	4.0	2.2	.9	.7	0	2.0
Fully developed	11.3	19.3	5.3	10.1	6.6	6.0	..7	3.0	6.3
Other reasons	<u>24.5</u>	<u>35.5</u>	<u>21.0</u>	<u>28.3</u>	<u>31.8</u>	<u>36.2</u>	<u>29.5</u>	<u>49.3</u>	<u>33.0</u>
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 26

ITEMIZATION OF OTHER REASONS FOR NOT IMPROVING PASTURE

Reason	Percentage
Sufficient pasture and not interested in more	35.5
Adverse weather	16.3
Age, health and impending retirement	14.3
Unable to forego grass production	2.8
Miscellaneous reasons	<u>31.1</u>
	<u>100.0</u>

TABLE 27

REASONS WHY OPERATORS WHO HAD IMPROVED SOME PASTURE IN 1964 DID NOT IMPROVE MORE PASTURE THAT YEAR

Reason	I	II	III	IV	V	VI	VII	VIII	Province
Better use of capital	8.7	7.1	22.6	18.2	29.7	18.8	42.5	28.6	22.0
Lack time	21.7	14.3	19.3	13.7	14.8	22.5	27.3	14.3	19.7
Unable to obtain cr credit	4.3	7.1	6.5	6.8	3.7	3.7	12.0	14.3	6.2
Too risky	8.7	0	6.5	4.5	3.7	2.5	3.0	0	3.9
Lack information	0	7.1	3.2	9.1	11.1	2.5	0	0	4.2
Fully developed	21.7	21.4	29.0	6.8	18.5	15.0	9.1	0	15.4
Other reasons	34.9	43.0	12.9	40.9	18.5	35.0	6.1	42.8	28.6
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 28

THE PERCENTAGE OF OPERATORS WITHIN EACH REGION HAVING MADE SOME IMPROVEMENT ON DEVELOPMENT OF PASTURE

I	II	III	IV	V	VI	VII	VIII	Province
30.5	35.2	65.3	33.3	26.7	27.2	19.9	12.8	27.8

TABLE 29

PERCENTAGE OF FARMS IN EACH TENURE GROUP REPORTING PASTURE IMPROVEMENT

	Full Owners	Part Owners	Full Tenants
Percent making improvement	27.5%	29.4%	16.7%

TABLE 30
THE PERCENTAGE OF OPERATORS WITHIN EACH IMPROVMENT GROUP WILLING TO MOVE CATTLE TO PASTURE AND THE RENTAL CHARGES THEY WOULD BE WILLING TO PAY

Improvement Group	Willing to move up to 30 miles	Willing to pay per month for cow & calf	Willing to move up to 60 miles	Willing to pay per month for cow and calf
Did improvement	50.3%	\$2.49	23.1%	\$2.59
Did not improve	41.4%	\$2.28	15.2%	\$2.17

TABLE 31
POTENTIAL ACREAGE TO IMPROVE AND DEVELOP FOR EACH IMPROVEMENT GROUP

Improvement Group	I	II	III	IV	V	VI	VII	VIII	Province
Made improvement	21	35	46	74	57	59	85	61	58
Made no improvement	28	37	38	48	62	51	79	99	60

TABLE 32

RESPONSE TO THE STATEMENT THAT SEEDING NATIVE PASTURE TO IMPROVED GRASS WOULD AT LEAST DOUBLE THE CARRYING CAPACITY

Response	I	II	III	IV	V	VI	VII	VIII	Provincial Average
Strongly agree	10.9	12.0	10.0	8.8	7.4	14.1	27.5	24.3	14.4
Agree	41.8	43.4	42.0	45.1	46.8	59.6	60.8	54.6	50.5
Disagree	29.1	10.8	14.0	25.8	23.9	14.1	4.1	4.6	15.8
Strongly disagree	1.8	2.4	4.0	2.2	3.7	1.3	--	--	1.9
Don't know	13.6	20.5	16.0	13.2	14.5	9.6	7.6	14.5	13.7
Not applicable	<u>2.8</u>	<u>10.9</u>	<u>4.0</u>	<u>4.9</u>	<u>3.7</u>	<u>1.3</u>	<u>--</u>	<u>2.0</u>	<u>3.7</u>
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 33

RESPONSE TO THE STATEMENT THAT THE COST OF RESEEDING PERMANENT PASTURE WILL BE RECOVERED WITHIN FOUR YEARS

Response	I	II	III	IV	V	VI	VII	VIII	Provincial Average
Strongly agree	5.5	6.0	12.0	7.7	5.9	12.0	15.8	12.8	9.6
Agree	56.4	43.4	60.0	57.7	57.4	62.1	18.0	59.9	58.1
Disagree	19.1	15.7	8.0	13.2	14.4	10.7	4.1	10.5	12.0
Strongly disagree	.9	1.2	--	2.2	1.1	.8	.9	--	.9
Don't know	14.5	21.7	16.0	16.5	17.5	13.1	10.8	15.8	15.7
Not applicable	<u>3.6</u>	<u>12.0</u>	<u>4.0</u>	<u>2.7</u>	<u>3.7</u>	<u>1.3</u>	<u>.4</u>	<u>2.0</u>	<u>3.7</u>
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 34

RESPONSE TO THE STATEMENT THAT SEEDING ABANDONED CROPLAND WITH IMPROVED GRASSES WOULD AT LEAST DOUBLE
CARRYING CAPACITY

Response	I	II	III	IV	V	VI	VII	VIII	Provincial Average
Strongly agree	19.1	12.0	16.0	11.0	11.2	10.4	12.5	16.4	14.8
Agree	58.2	42.2	46.0	42.3	51.1	50.3	45.5	41.4	47.1
Disagree	8.2	9.6	6.0	2.7	6.4	7.0	1.8	2.0	5.5
Strongly disagree	.9	1.2	0	1.6	1.6	.5	--	--	.7
Don't know	9.1	13.2	14.0	10.5	15.3	10.7	9.5	19.7	12.8
Not applicable	<u>4.5</u>	<u>21.7</u>	<u>18.0</u>	<u>31.9</u>	<u>14.4</u>	<u>21.2</u>	<u>20.7</u>	<u>20.5</u>	<u>19.1</u>
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 35

OPERATING ADJUSTMENTS TO VARIATION IN PASTURE PRODUCTION, PERCENT OF FARMERS USING EACH

Adjustment	I	II	III	IV	V	VI	VII	VIII	Provincial Average
Change livestock numbers to fit pasture produc- tion each year	30.4	35.2	28.6	25.6	29.5	22.1	14.0	13.7	24.9
Maintain one third to one half the vegetative cover as carryover on summer pasture	15.2	1.9	4.1	6.7	4.8	2.9	2.1	2.1	5.0
Use most of roughage in good years and buy feed when pasture is short	15.2	24.1	26.5	17.7	14.4	22.7	16.6	11.6	18.6
Base use on average production storing excess forage from good years for use in poor years	39.2	38.8	40.8	50.0	51.3	52.3	67.3	72.6	51.5

TABLE 36
FORAGE CARRYOVER OF FARMERS WHO REPLIED THAT THEY STORED FEED RESERVES FOR POOR YEARS

Total Making Such a Response	Number Having Any Carryover in Spring of 1964	Number Reporting a Carryover of More Than 5%	Number Reporting Carryover of More Than 10%
570	231	205	1

TABLE 37
LAND VALUES THROUGHOUT THE PROVINCE

	I	II	III	IV	V	VI	VII	VIII	Provincial Average
				(dollars per acre)					
Pastureland	16.00	36.00	62.00	54.00	32.00	36.00	24.00	13.00	34.00
Cropland	35.00	98.00	116.00	93.00	74.00	97.00	56.00	54.00	78.00

TABLE 38

PERCENTAGE DISTRIBUTION OF FARMS IN ALBERTA HAVING SELECTED NUMBERS OF CATTLE ON JANUARY 1, 1965 -
BY GRAZING REGIONS

Number of Cattle in Size Group	Sum of Col. 1 Through Col. 5				
	1-25	26-50	51-75	76-100	101+
Column Number	1	2	3	4	5
Grazing Region	(percent)	(percent)	(percent)	(percent)	(percent)
	(percent)	(percent)	(percent)	(percent)	(percent)
I	20.2	24.1	7.8	7.8	26.2
II	26.5	19.3	4.8	3.6	14.5
III	23.0	27.1	10.4	10.4	25.0
IV	16.5	18.1	10.4	13.7	27.5
V	16.5	20.8	14.9	10.1	17.0
VI	33.0	27.8	15.4	4.7	6.8
VII	35.6	28.0	9.0	3.1	5.0
VIII	38.8	13.1	5.9	2.0	1.3
Province	27.4	22.7	11.7	6.4	12.7
					80.9

TABLE 39

PERCENTAGE DISTRIBUTION OF FARMS IN ALBERTA HAVING TOTAL CATTLE
SALES OF SELECTED SIZES DURING THE YEAR 1964 BY GRAZING REGIONS

Amount of Sales in dollars	Less Than \$1,000	\$1,000 to 4,999	\$5,000 to 9,999	\$10,000 to 24,999	\$25,000 and Over	Percent of Farms Selling Cattle
Column	1	2	3	4	5	6
Grazing Region	(percent)	(percent)	(percent)	(percent)	(percent)	
I	13.6	40.9	12.7	5.5	27.3	100.0
II	19.3	22.9	10.8	4.8		58.8
III	25.0	37.5	14.6	8.3		85.4
IV	12.6	39.0	18.7	8.2		78.5
V	15.4	36.7	14.9	8.0		75.0
VI	35.2	39.1	5.7	2.9		82.9
VII	40.0	33.4	1.8	.5		75.7
VIII	30.2	14.1	2.0			49.3
Province	26.6	34.8	8.9	4.2		76.7 ^a

^a While 80.7 percent of the farms in Alberta reported cattle owned January 1, 1965, only 76.7 had cattle sales during 1964. A difference of 4.2 percent existed between those who owned cattle and those having sales in 1964.

APPENDIX B

The Matrix

Each region in the matrix was characterized by a number of activities and constraints. The activities included the improvement and development of pasture which supplied grazing and winter feed. There were the four activities representing the production and sale of livestock. In addition, there were a number of constraints which included the limited amounts of land available for improvement and development. A number of accounting functions were inserted.

Associated with each region were a number of slacks or disposal activities. These slacks allowed for the non-use of resources and enabled the use of equalities in the constraints functions rather than inequalities between use and supply.

Using the Southeast as an example and inserting an +a to represent coefficients other than zero, the workings of the matrix can be more clearly outlined. The -a indicates production or output, while the +a indicates the using up of a resource.

The three improvement activities--reseed, irrigate, and add watering facilities--used up a part of the acreage available for each type of improvement (a in the respective "Land" rows, (Table 40). In addition, they supplied some grazing capacity (-a's in Grazing Capacity and Use row) and provided some returns to meet forage production costs (-a's in Profit row). The calves produced by the cow calf operation producing calves for the feedlot were added to the supply of calves (-a in Calf Production - Feedlot row). The cow-calf operation which sold calves to other regions was controlled by a balance equation which related the provincial production of calves for sale to other regions with the demand for such cattle.

TABLE 40

OUTLINE OF REGIONAL MATRIX

	Activities										Slacks									
	Reseed	Irrigate	Add Watering Facilities	Cow Calf-Calves to Feedlot	Cow Calf-Calves Sold for Other Reasons	Cows and Raise Calves to Yearlings	Buy Outside Calves and Raise to Yearlings	Land to Reseed - Slack	Land to Irrigate - Slack	Land Requiring Additional Water Facilities - Slack	Feeder Calves	Feeder Yearlings	Profit - Slack	Right Hand Side						
Land to Reseed	a								a					a						
Land to Irrigate		a								a				a						
Land Requiring Additional Watering Facilities			a											a						
Grazing Capacity and Use	-a	-a	-a	a	a	a	a							0						
Calf Production-Feedlot				-a										0						
Feeder Yearling Production						-a	-a							0						
Profit				-a	-a	-a	-a							0						

Date		Description		Amount	
1912	Jan 1	Balance forward			
1912	Jan 15	Received from John Doe			
1912	Feb 1	Received from Jane Smith			
1912	Mar 1	Received from Mr. Brown			
1912	Apr 1	Received from Mrs. Green			
1912	May 1	Received from Mr. White			
1912	Jun 1	Received from Mr. Black			
1912	Jul 1	Received from Mr. Grey			
1912	Aug 1	Received from Mr. Blue			
1912	Sep 1	Received from Mr. Yellow			
1912	Oct 1	Received from Mr. Purple			
1912	Nov 1	Received from Mr. Pink			
1912	Dec 1	Received from Mr. Brown			
1912	Dec 31	Balance forward			

CHAS. E. HENNINGSEN

1912

This balance equation is not shown. The activity producing calves and raising them to yearlings produced feeder yearlings which were recorded by the -a in the Feeder Yearling Production row. The raising of purchased calves to yearlings draws calves from the provincial balance equation mentioned above and adds to the supply of feeder yearlings.

The slacks allowed the equating of the use and the supply of land. Using Land to Reseed, for example, the Reseed activity may have used up a portion of the value on the Right Hand Side. The Land to Reseed Slack activity accounted for what was remaining so as to maintain the equality. The other land activities and constraints operate similarly. In the case of Grazing Capacity and Use, all the grazing capacity generated was assumed to be fully utilized so no slack was required. The Feeder Calves disposal activity accounted for the calves raised and sold to feedlots as stocker calves. Feeder Yearlings was the slack accounting for the yearling production within the region, both of regionally produced and purchased calves. The disposal activity, Profit-Slack, was the difference between the returns available to meet the cost of producing forage requirements and the actual cost of producing the necessary forage.

Similar sub-matrices existed for all the other regions. These were combined and interrelated by provincial constraints and slacks to construct a provincial matrix. The complete matrix showing the coefficients for one problem is given in the following matrix.

[illegible]

APPENDIX C

Further Detail of Selected Pasture

Improvement and Development Costs

TABLE 41
ANNUAL COST OF DEVELOPING FLOOD IRRIGATED PASTURE FROM NATIVE RANGE¹

	Southeast	Irrigation
	(Dollars per acre)	
Development cost amortization ^a	\$ 4.00	\$ 4.00
Interest ^b	3.00	3.00
Operating costs	21.00	21.00
Fertilizer	14.70	
Spreading	.50	
Annual cost of maintenance including reseeding after 10 years	<u>2.18</u>	<u>2.18</u>
Total annual cost	45.38	30.18

¹ Calculations based on information provided by H. W. Thiessen, Supervisor of Grazing Reserves, Department of Lands and Forests, Lethbridge, whose cooperation was much appreciated.

^a Development cost of \$80.00 per acre amortized over 20 years.

^b Interest at five percent on average value if no rennovation or improvement of irrigation facilities.

TABLE 42

COSTS OF RESEEDING DRYLAND PASTURES WITHIN REGIONS

	Southeast	Irrigation	Foothills	Northern Prairie	Black	Grey Wooded
	(Dollars per acre)					
Cultivation ^a						
deep tillage (twice) or plow	\$1.48	\$1.48	\$1.44	\$1.44	\$1.54	\$1.54
disk			.81	.81	1.64	1.64
harrow			.38	.38	.40	.40
seed grass	.66	.66	.66	.66	.66	.66
Grass seed	2.70	2.66	3.60	3.60	4.65	5.32
Value of lost grazing	2.03	2.03	3.94	2.38	1.25	.62
Total initial cost	6.87	6.87	10.83	9.27	10.14	10.18
Years over which invest- ment is amortized	20	20	10	10	10	10
Annual cost ^b	.513	.513	1.35	1.158	1.268	1.263

^a Farm Machinery Rates - Alberta, Publication 825, (Edmonton: Alberta Department of Agriculture).

^b Interest at 5 percent on one half the investment included.

TABLE 43

RECOMMENDED FORAGE MIXTURES FOR PASTURE (POUNDS PER ACRE) AND COST¹

	Irrigated Pasture	Southeast	Foothills and Northern Prairie	Black ^a		Grey Wooded
				(a)	(b)	
(Dollars per acre)						
Brome grass (\$.26/lb)	7			8	6	6
Creeping Red Fescue (\$.60/lb)	4					3
Orchard grass (\$70/lb)	7					
White Dutch Clover (\$.65/lb)	2					
Crested wheat grass (\$.32/lb)		(3) ^b	(3)		3	
Russian wild rye (\$.28/lb)		(3)	(3)			
Rambler alfalfa (\$.90/lb)		1	2	(1.5)	(1.5)	(1.25)
Ladak alfalfa (\$.67/lb)				(1.5)	(1.5)	(1.25)
Total cost of seed	\$10.42	\$2.70	\$3.60	\$4.43	\$4.87	\$5.32
				(average is \$4.65)		

¹ Recommended mixtures from Hay and Pasture Crops for Alberta, Publication 63, (Edmonton: Alberta Department of Agriculture). 11-13, and seed prices from 1966 price lists.

^a Both mixtures recommended, the average cost of the two was used.

^b Brackets indicate where either seed could be used at twice the rate in brackets if only one of the two was used.

TABLE 44
COST OF CLEARING, BREAKING AND SEEDING LAND TO PASTURE

	Black	Grey Wooded
	(Dollars per acre)	
Clear	\$20.41 (24.99) ^a	\$16.75 (21.69)
Break	11.93	12.11
Disk (twice)	1.64	1.64
Float	1.36	1.36
Seed	.66	.66
Grass Seed	4.65	5.32
Value of lost grazing	<u>.38</u>	<u>.38</u>
Total initial cost	41.03 (45.61)	38.22 (43.16)
Cost to reseed in 10 years	10.14	10.18
Annual cost ^b	4.74 (5.19)	4.45 (4.95)

^a Figures in brackets are the average at experienced and estimated costs of clearing and the results of using these figures. Those not in brackets are based upon actual costs experienced alone.

^b Includes an interest charge at five percent.

APPENDIX D

This appendix provides additional information concerning the costs of producing calves in the Peace River Region and of wintering calves and raising them to yearlings in all districts. No further itemization of cow calf costs were provided for the other regions since this information was furnished by the Farm Economics Branch of the Provincial Department of Agriculture for their analysis and publication.

TABLE 45

ESTIMATED COSTS PER COW IN COW CALF OPERATIONS-PEACE RIVER REGION¹

Roughage Fed as Winter Feed	2.3 tons at \$15.39	\$35.40
Composition		
25% straw (\$10. per ton)		
17% green feed (\$12. per ton)		
15% grass hay (\$15. per ton)		
43% legume mix (\$20 per ton)		
Pasture Charge		10.20
Grain Fed ^a		
Oats	218.2 lb. (1.74¢ per lb)	
Barley	74.1 lb. (2¢ per lb)	
Straw for Bedding	.4 tons (\$10.00 per ton)	4.00
Salt, Mineral and Vitamin A		1.43
Veterinary & Medicine Expenses		1.80
Repair and Maintenance		2.70
Building and Equipment		4.50
Interest on Livestock Investment		8.50
Miscellaneous Expenses		2.60
Labor Charge ^b		<u>15.92</u>
Total Cost		\$92.33

¹ Calculated from the data presented by J. D. MacKenzie, "Resource Requirements for the Production of Beef Calves and Yearlings in the Peace River Area at Alberta," Agricultural Economics Special Report 2, (Edmonton: Dept. of Agricultural Economics, University of Alberta, 1966).

^a Charges include a portion for the herd sire.

^b MacKenzie reported 35 hours of labor per animal unit. Even at a low hourly charge this cost would be very high. Consideration of other data reduced the charge which still is higher than any reported on the Farm Business Analysis.

TABLE 46

COSTS OF WINTERING AND PASTURING CALVES TO PRODUCE FEEDER YEARLINGS

	Southeast and Irrigation		Foothills and Northern Prairie		Black and Grey Wooded	
Oats ^b	260 lb.	\$4.68	331 lb.	\$5.96	372 lb.	\$6.70
Hay (cost to put up at \$6.00 per ton)		4.29		6.00		6.70
Protein	5.2 lb.	.90	6.6 lb.	1.10	9.6 lb.	1.55
Salt, Minerals and Vitamin A		.74		.74		.74
Bedding		2.00		3.00		4.00
Building & equipment		2.00		3.50		5.00
Veterinary and miscellaneous		4.00		4.00		4.00
Labor		2.80		3.50		4.20
Death Loss - 3% of variable costs		2.66		3.11		3.05
Initial cost of calf (384.4 pounds)		79.42		79.42		73.80
Interest 5%		<u>3.80</u>		<u>3.80</u>		<u>3.23</u>
Total cost less charge for forage for pasture		107.29 112.05 ^a		114.13		112.97

^a Cost in Irrigation Region are assumed to be 4.6% greater than in the Southeast, as were the cow calf operation costs.

^b Feed requirements meet National Research Council standards.

QUESTIONNAIRE NUMBER

THE QUESTIONNAIRE

Economic Efficiency in Pasture Production and
Improvement in Alberta

Name of Interviewer

Interviewer's Number

Census Division

1

2

SECTION I - PERSON NOW IN CHARGE

Surname or family name

Given name and initials

Post office address

Operation History

1. Were you operating a farm in 1961?
(If no go to next section)

No ☐ Yes ☐

2. Was your farm headquarter the same as it is now?
(If yes go to next section)

No ☐ Yes ☐

3. Was your 1961 farm headquarters less than 20 miles from your present
farm headquarters?

No ☐ Yes ☐

4. Is anyone presently farming or using the land you farmed in 1961?

No ☐ Yes ☐
Don't know ☐

5. If yes, what is his name and address?

Don't know ☐

name

Address or location

6. Was he farming in 1961?

No ☐
Yes ☐How far from his present farm? _____ miles.
Don't know ☐

SECTION II - OWNERSHIP AND TENURE

7. How many years have you been operating a farm or ranch?
(check one)

(1) 30 or more ☐(2) 20-29 ☐(3) 10-19 ☐(4) 1-9 ☐

3

8. How many years have you operated this holding?
(check one)

(1) 20 or more ☐(2) 15-19 ☐(3) 10-14 ☐(4) 5-9 ☐(5) Less than 5 ☐

4

9. How many months did you live on this holding during 1964?
(check one)

(1) 9-12 ☐(2) 5-8 ☐(3) 1-4 ☐(4) Did not live on this holding ☐

5

Questionnaire Number

WE NOW WANT TO TALK ABOUT YOUR FARMING AND RANCHING OPERATIONS FOR 1964.

10. OWNED LAND: How many acres do you own? (regardless of where located).

None ☐

6

acres

LAND RENTED OR LEASED TO OTHERS: (Include land worked on shares by others.

11. How many acres that you own do you rent to others?

None ☐

7

acres

12. Subtracting question 11 from question 10 we get the total acreage owned and operated by you.

8

acres

13. How many acres do you RENT FROM PRIVATE OWNERS: (Include acres worked on shares?)None ☐

9

acres

WE NOW ENQUIRE ABOUT YOUR USE OF LANDS LEASED FROM CROWN OR PUBLIC LANDOWNERS IN 1964.

14. Did you lease any lands from the following:

No

Yes

acres

(a) Provincial Department of Lands and Forests

☐☐

10

(b) Provincial Department of Municipal Affairs

☐☐

11

(c) Federal Government i.e. Parks or Indian Reserves

☐☐

12

(d) Total acres leased from public sources

None ☐

13

ACRES IN THIS PLACE

15. Adding questions 12, 13 and 14(d) we get

14

acres in this place

1964 Classification of LAND USE BY OWNERSHIP

Acres for:

(a) Hay, silage and greenfeed

(b) Grain, Seed and summerfallow

(c) Pasture (total of all kinds)

(d) Unused land

(e) Total acres

	Owned	Rented from Private Owners	Leased from Public Owners
15	16	17	
18	19	20	
21	22	23	
24	25	26	
27	28	29	
			30

TOTAL MUST CHECK WITH NUMBER 15

acres in this place

16. How many tons of hay, silage or greenfeed did you harvest in 1964 on:

(a) Owned Land

None ☐

(b) Rented from Private Owners ☐

(c) Leased from Public Owners ☐

Total

Tons

31

32

33

34

WE NOW ENQUIRE ABOUT GRAZING WHICH YOU OBTAINED ON A PER HEAD BASIS PER MONTH OR PER SEASON

17. In 1964 did you have grazing privileges from any of the following sources?

No

Yes

Number of head

Class, age or kind

Number of months grazed

Total Animal Unit months

Per head per month cost

(a) From Private landowners? ☐

☐

(b) Community pasture? ☐
If yes, give name: _____

☐

☐

(c) On a Grazing Reserve? ☐

☐

☐

(d) On a Forest Reserve? ☐

☐

☐

(e) On Indian Reserves or Federal Crown Lands? ☐

☐

☐

(f) Other Provincial Crown Lands? * ☐

☐

☐

* specify i.e. give name of association

name

Total A. U. M.

59

(to be computed by Interviewer)

SECTION III - CROPS FED OR SOLD 1964

Report all crops sold or fed during 1964.

SMALL GRAIN: (Include landlord's share as sold if taken from this place)

Were any of the following crops fed or sold in 1964?

	None	bushels sold	bushels purchased for feed to cattle sheep and horses	bushels fed
18. Wheat	<input type="checkbox"/>	60	61	62
19. Oats	<input type="checkbox"/>	63	64	65
20. Barley	<input type="checkbox"/>	66	67	68
21. Rye	<input type="checkbox"/>	69	70	71
22. Flaxseed	<input type="checkbox"/>	72	73	74
23. Mustard	<input type="checkbox"/>	75		
24. Rapeseed	<input type="checkbox"/>	76		
25. Other (clover alfalfa grass seed)	<input type="checkbox"/>	77		
26. What was the total value of all grains sold from this place in 1964?				None <input type="checkbox"/> 78

FORAGE CROPS: (If two or more cuttings count the acres only once but give the total production of all cuttings. Include the landlord's share as sold if taken from this place).

	None	How many tons were fed	How many tons were purchased	How many tons were sold	What was your carryover at the end of the feeding season in the spring of 1964 (tons dry basls)
27. Tame Hay	<input type="checkbox"/>	79	80	81	82
28. Native Hay	<input type="checkbox"/>	83	84	85	86
29. Cereal grains cut as greenfeed	<input type="checkbox"/>	87	88	89	90
30. Silage	<input type="checkbox"/>	91	92	93	94
31. Other ()	<input type="checkbox"/>	95	96	97	98
					Column Total 99

Questionnaire Number

32. What was the value of all hay, greenfeed and silage sold from this place in 1964?

None ☐

100

101

total grain and forage
sales

32. (a) Adding questions 26 and 32 we obtain the total value of all grain and forage sold from this place in 1964.

SECTION IV - LIVESTOCK NUMBERS ON THIS PLACE
DURING 1964

(Include all animals on this place owned by you, by your landlord, by your employees and others. Include livestock grazing on land under a head tax or per head per month grazing allotment with private owners and on Crown lands).

33. How many cattle and calves of all ages were on this place January 1st, 1965?

None ☐

102

number

WE NOW ENQUIRE ABOUT CATTLE OPERATIONS DURING 1964.

A RECORD OF CATTLE OPERATIONS DURING 1964

Type or Class	Number on hand Jan 1st 1964 (1)	Born & Weaned during 1964 (2)	Purchased during 1964 (3)		Sold during 1964 (4)		On hand January 1st 1965 (5)	Feedlot operations during 1964	
								Number grain fed for market	Number of months fed
			Number	Value	Number	Value		(6)	(7)
34. Bulls, cows & heifers 2 yrs. old and over. None <input type="checkbox"/>	103		104	105	106	107	108	109	110
35. Calves 1 yr and under None <input type="checkbox"/>	111	112	113	114	115	116	117	118	119
36. Yearling heifers and steers. None <input type="checkbox"/>	120		121	122	123	124	125	126	127
37. Two year olds and others None <input type="checkbox"/>	128		129	130	131	132	133	134	135
38. Dairy cows & heifers, 2yrs old milked dur ing 1964. (include dual purpose cows) None <input type="checkbox"/>	136		137	138	139	140	141	142	143

144

39. How many ewes, rams, wethers and lambs of all ages were on this place on January 1st 1965?

None

number

Type or Class	Number on hand Jan 1st 1964 (1)	Born & weaned during 1964 (2)	Purchased during 1964 (3)		Sold during 1964 (4)		On hand January 1st 1965 (5)	Feed lot operations during 1964	
			Number	Value	Number	Value		Number grain fed for market (6)	Number of months fed (7)
40. Lambs under 1 year. None <input type="checkbox"/>	145	146	147	148	149	150	151	152	153
41. Ewes 1 year old and over. None <input type="checkbox"/>	154		155	156	157	158	159	160	161
42. Rams and wethers 1 year old and over. None <input type="checkbox"/>	162		163	164	165	166	167	168	169

None ☐

Number 170

None ☐

Value \$

None ☐

Number

None ☐

Number 174

Value \$

(1) No ☐
(2) Yes ☐

Quantity sold

How much was the value of sales in 1964?

None ☐

(1. lbs of milk
(177
(
(or 2. gallons of milk
(
(
(or 3. lbs of butterfat

178

48. How much cream was sold in 1964? (If cream was sold by the gallon, multiply the number of gallons by $2\frac{1}{2}$ to get pounds of butterfat).

None ☐ lbs of butterfat

179

Value \$

180

49. Total value of livestock and livestock product sales during 1964.
(to be completed by interviewer)

\$

181

SECTION V - SELECTED FARM EXPENDITURES AND LAND-USE PRACTICES DURING 1964

(Include expenditures paid by you or your landlord for this place)

On how many acres were commercial fertilizer and fertilizing materials used in 1964? (use of fertilizer and lime on this place in 1964 whether purchased by you or your landlord).

None ☐

182

acres

Was fertilizer used during 1964 on any of the following crops?

No

On how many acres was fertilizer used.	How much was used?	Total Cost
183	184	185
186	187	188
189	190	191
192	193	194

50. Forage crops

☐

51. Tame Pasture

☐

52. Cropland for grain and seed

☐

53. Other

☐

How much was spent in 1964 for:

54. Feed bought for cattle, sheep and horses? (Include cost of mill feed, pellets, concentrates and supplements, also amounts paid for grinding and mixing, exclude hay, straw and other roughage).

None ☐

Total \$

195

How much was spent in 1964 for:

55. Seeding permanent pastures? (Include cost of seedbed preparation seed and seeding)

None ☐

If yes, acres

Total \$

196

197

How much was spent in 1964 for:

56. Spraying pastures?

None ☐

If yes, acres

Total \$

198

199

How much was spent in 1964 for:

57. Clearing brush or trees from pasture? (Not including new breaking)

None ☐

If yes, acres

Total \$

200

201

58. (a) What was the cash outlay for fence repair during 1964?

None ☐

Total \$

202

(b) How many miles of fence were maintained on this place during 1964?

None ☐

Number of miles

203

How much was spent in 1964 for:

59. New fencing for pastures? (either temporary or permanent fencing)

None ☐ If yes, number of miles

204

Total \$

205

How much was spent in 1964 for:

60. New wells, windmills and tanks or other new watering facilities?

None ☐ If yes, number of such improvements

206

Total \$

207

61. (a) What was the cash outlay for maintenance for watering facilities during 1964?

None ☐ Total \$

208

(b) How many watering facilities were maintained on this place during 1964?

None ☐ Number

209

How much was spent in 1964 for:

62. Irrigation development expenses for pasture? (include new ditches, wells, sprinkler equipment).

None ☐ If yes, number of acres irrigated

210

Total

211

SECTION VI - PASTURE MANAGEMENT AND ESTIMATED GRAZING CAPACITY

63. Is any of your pasture part of a crop rotation?

No ☐ Yes ☐

If yes, what portion?

- (1) one quarter ☐
 (2) one half ☐
 (3) three-quarters ☐
 (4) all ☐

213

acres

64. In 1964 did you have (1) more ☐
 (2) less ☐
 (3) the same ☐

pasture acreage than in 1963?

214

acres

65. If yes, how was it obtained?

Lease.....

215

Rent.....

216

Purchase.....

217

Development of idle land.....

218

Increased pasture acreage in the rotation

219

Per head grazing - number of head

220

- number of months

221

Questionnaire Number

66. Do you own any land which it would be profitable to develop for pasture that is not now being used for pasture?

No ☐ Yes ☐
If yes, how many acres

222

acres

223

224

225

226

(a) Type of land:

abandoned cropland

No ☐

virgin land

☐

cropland

☐

unused waste or idle

☐

(b) What development practices would be required on this land?

None ☐

(1) Plow or prepare a seed bed and reseed

No ☐

(2) Spray or mow to control brush & weeds

☐

(3) Clearing brush and trees

☐

(4) Drainage

☐

(5) Other

(specify)

☐

Totals

Acres	Cost per acre	Total*
227	228	229
230	231	232
233	234	235
236	237	238
239	240	241
242		243

(*to be completed by interviewer) %

(c) Did you develop any such land in 1964?
(If yes, skip to 8 below) If no, why?

No ☐ Yes ☐(1) ☐ could not borrow needed capital(2) ☐ too risky (If checked ask why)(3) ☐ lack of time(4) ☐ more profitable use of limited capital elsewhere in the business(5) ☐ lack of information concerning costs, returns, and production which may be obtained from development practices.(6) ☐ Other(7) ☐ All owned land now fully developed.

(8) If yes, list treatments used:

(* Refer back to question 66 (b) for
treatment code)

(a)

(b)

(c)

treatment code *	number of acres	Total cost
245	246	247
248	249	250
251	252	253
		254

Total cost of pasture development during 1964

67. Concerning the land you are now using for pasture which two of the pasture improvement practices or treatments listed on this page do you consider most profitable?

(List them in the order of your preference) (Show page)

Treatment	Number of acres it could be applied to.
255	256
257	258
	259

Did you use any of these pasture improvement practices in 1964?

(1) No ☐

(2) Yes ☐

If yes, which ones?

Treatment	Number of acres	Total Cost
260	261	262
263	264	265

68. (a) Are there other pasture improvement practices which you regard as highly profitable for your present operation? (i)

(1) No ☐

(2) Yes ☐

766

treatment

number of acres it could be applied to

treatment

number of acres it could be applied to

(b) Did you use any of these pasture improvement practices in 1964?

(1) No ☐
(2) Yes ☐

267

If yes, which ones?

treatment

Number of acres	Total cost
268	269
270	271
improvement during 1964. costs in questions 67 & 68)	272

Total cost of pasture improvement during 1964.
(sum of improvement costs in questions 67 & 68)

69. Why didn't you improve more pasture acreage during 1964?

- (1) ☐ could not borrow needed capital
- (2) ☐ too risky (if checked ask why?) _____
- (3) ☐ more profitable use of limited capital elsewhere in the business _____
- (4) ☐ lack of time
- (5) ☐ lack of information concerning costs, returns and production which may be obtained from improvement practices
- (6) ☐ all land under my control was fully developed in 1964 or prior years
- (7) ☐ other _____
(specify) _____

273

SECTION VII - ATTITUDES CONCERNING PASTURE PRODUCTION AND EFFICIENCY

ASSUME YOU ARE INTERESTED IN BUYING PASTURE LAND IN THIS AREA.

70. How much would you be willing to pay per acre?

Don't know ☐

Please describe the type of pasture you have in mind:

274	
275	

Questionnaire Number _____

ASSUME YOU ARE INTERESTED IN BUYING CROPLAND IN THIS AREA

71. How much would you be willing to pay per acre?

Don't know ☐Please describe the type of cropland you have in mind: _____

276

277

72. (a) If good grazing land with adequate supervision were available on a per head charge, within 30 miles would you be willing to move cattle to it?

(1) No ☐(2) Yes ☐

278

(b) If yes, how much would you be willing to bid per head per month for such grazing?\$ per head
per monthSpecify type:
(* see code below)

279

280

73. (a) If good grazing land with adequate supervision were available on a per head charge, within 60 miles would you be willing to move cattle to it?

(1) No ☐(2) Yes ☐

281

(b) If yes, how much would you be willing to bid per head per month for such grazing?

\$ per head
per monthSpecify type:
(* see code)

282

283

* Code	Type
(1)	Cow and calf
(2)	Calf
(3)	Yearlings
(4)	Two-year old
(5)	Ewe and lamb
(6)	Wether
(7)	Horse or pony

WE ARE NOW GOING TO READ SOME STATEMENTS AND DESIRE THAT YOU REPLY WITH ONE OF THE FOLLOWING:
strongly agree, agree, disagree, strongly disagree, don't know, or does not apply to this place.

74. Seeding native pastures with improved grasses will at least double the carrying capacity.

(1) ☐ strongly agree(2) ☐ agree(3) ☐ disagree(4) ☐ strongly disagree(5) ☐ don't know(6) ☐ does not apply

284

75. Seeding abandoned cropland with improved grasses will at least double carrying capacity.

(1) ☐ strongly agree(2) ☐ agree(3) ☐ disagree(4) ☐ strongly disagree(5) ☐ don't know(6) ☐ does not apply

285

76. Exclude rotation pastures, the cost of reseeding will be recovered within four years.

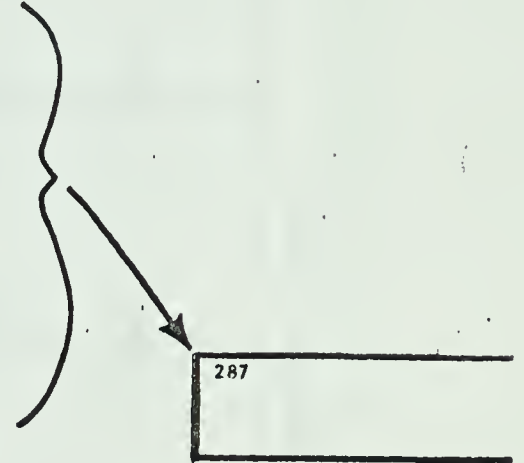
(1) ☐ strongly agree(2) ☐ agree(3) ☐ disagree(4) ☐ strongly disagree(5) ☐ don't know(6) ☐ does not apply

286

Questionnaire Number

77. Which of these operating adjustments most nearly fits your method of handling year to year variations in pasture production.
(Show page as typed below)

- (1) ☐ Change your livestock numbers to fit pasture production each year.
- (2) ☐ Keep one third to one half of the vegetative cover as an average carryover on summer pastures.
- (3) ☐ Plan your livestock program so most of the pasture is used in good years; buy additional roughage in poor years.
- (4) ☐ Plan your livestock program on basis of average pasture yields. Store surplus feed from good years to use in poor years.



287

78. Name and address of one or two operators in this community who have carried out extensive pasture improvement practices:

Name	Address
Name	Address

79. How many pastures are on this place?

Number

288

TABLE I

GRAZING RECORD FOR THIS PLACE DURING 1964

Questionnaire Number

Pasture Tract Number or Name:

1. Number of acres in this pasture

2. Number owned

3. Number leased from individuals or private corporations

4. Number leased from public agency

LEASING

ARRANGEMENTS: 5. Length of term (years)

6. Cost per acre

7. Kind of (1) unimproved native*

Pasture: (2) improved native

(3) Tame

(4) Rotation

8. Has increased weed growth been troublesome in recent years? (exclude brush) No Yes

9. PASTURE CONDITION

which of the following photographs most nearly resemble the condition of this tract at the end of the 1964 grazing season? (Write in 1, 2, 3, or 4)

10. (To be obtained from last column of Table II) Number of Animal Unit Months of Grazing

1.	2	3.	4.	5.	6.	7.	8.
289	290	291	292	293	294	295	296
297	298	299	300	301	302	303	304
305	306	307	308	309	310	311	312
313	314	315	316	317	318	319	320
321	322	323	324	325	326	327	328
329	330	331	332	333	334	335	336
337	338	339	340	341	342	343	344
345	346	347	348	349	350	351	352
353	354	355	356	357	358	359	360
361	362	363	364	365	366	367	368

* No PHYSICAL OR CHEMICAL ACTION USED TO IMPROVE VEGETATIVE COVER

Questionnaire Number

Census Division

THE QUESTIONNAIRE

ECONOMIC EFFICIENCY IN PASTURE PRODUCTION
AND IMPROVEMENT IN ALBERTACOST STUDY

SECTION I PERSON NOW IN CHARGE

Surname or family name

STRICTLY CONFIDENTIAL

WHEN COMPLETED

Given name and initials

Post office address

SECTION II PASTURE COSTS AND RETURNS

Please fill in the blanks below:

1. Concerning your farm as operated during 1965:

(a) how many acres do you own? _____ acres

(b) how many acres do you rent or lease? _____ acres

(c) the total farm acreage is _____ acres

2. During 1965 how many acres did you use solely for pasture? _____ acres

3. Number of cattle and calves on hand November
1st, 1965. (check box if none)☐4. Number of sheep and lambs on hand November
1st, 1965. (check box if none)☐5. Number of horses and ponies on hand November
1st, 1965. (check box if none)☐Please do not fill
in this columnPASTURE IMPROVEMENT PRACTICES USED DURING THE PAST THREE (3) YEARS6. Did you clear trees to improve pasture?☐ No, if "No" go to question 7.☐ Yes, if Yes complete (a) to (d) below.

Please do not fill
in this column

6.(a) On how many acres were trees cleared? _____ acres

(b) How much did clearing cost per acre? \$_____ per acre

(c) Did you hire the work done? No ☐ Yes ☐(d) How was the clearing done
(check the correct boxes)☐ Brush cutter☐ Bulldozed and piled☐ Other _____
please specify7. Did you seed tame grass on newly cleared land without any further seed-bed preparation (i.e. the land was not broken)?☐ No, if "No" go to question 8.☐ Yes, if yes complete (a) to (f)

(a) How many acres of such land were seeded to tame grass? _____ acres

(b) How much did the seeding cost per acre? \$_____ per acre

(c) Did you hire the work done? No ☐ Yes ☐(d) How long was the development period, i.e. after seeding how many months passed before grazing began? _____ months

(e) What mixture and amount did you use (please list below)

Kind and Variety

Pounds per acre

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

(f) When seeding this type of land to grass how often have you experienced failures?

(check the correct box)

☐ never☐ seldom☐ often

please do not fill
in this column

8. Did you break cleared land and seed to tame grass to improve pasture?

☐ No, if "No" go to question 9.

☐ Yes, if yes complete (a) to (d) below

(a) How many acres were broken? _____ acres

(b) How was breaking done?
(check correct boxes)

☐ Plow

☐ Heavy disk

☐ Rotary plow

☐ Other _____
please specify

(c) How much did the breaking cost per acre? \$ _____ per acre

(d) Did you hire the work done? No ☐ Yes ☐

9. Did you use the practice of brush control?

☐ No, if "No" go to question 10.

☐ Yes, if yes complete (a) to (e) below

(a) On how many acres was brush controlled? _____ acres

(b) Did you hire the work done? No ☐ Yes ☐

(c) How much did the brush control cost per acre? \$ _____ per acre

(d) Kind of brush controlled
(check correct boxes)

☐ Poplar

☐ Willow

☐ Buckbrush (snowberry or wolfwillow)

☐ Other _____
please specify

(e) What method of control did you use?
(check correct boxes)

☐ Aerial spraying

☐ Ground spraying

☐ Other _____
please specify

Please do not fill
in this column

10. Did you seed any native pasture to tame grass?

☐ No, if "No" go to question 11.

☐ Yes, if yes complete (a) to (f)

(a) How many acres of native pasture were seeded to tame grass? _____ acres

(b) How much did the seeding cost per acre? \$_____ per acre

(c) Did you hire the work done? No ☐ Yes ☐

(d) How long was the development period, i.e. after seeding how many months passed before grazing began? _____ months

(e) What grass mixture and amount did you use (please list below)

Kind and variety

Pounds per acre

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

(f) When seeding native pasture land to grass how often have you experienced failures?
(check correct box)

☐ never

☐ seldom

☐ often

11. Did you seed abandoned cropland to pasture?

☐ No, if "No" go to question 12.

☐ Yes, if yes complete (a) to (f) below

(a) How many acres of abandoned cropland were seeded to pasture? _____ acres

(b) How much was the total cost per acre? \$_____ per acre

(c) Did you hire the work done? No ☐ Yes ☐

(d) How long was the development period, i.e. after seeding how many months passed before grazing began? _____ months

Please do not fill
in this column

11.(e) What grass mixture and amount did you use?

Kind and variety

Pounds per acre

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

(f) When seeding abandoned cropland to grass how often have you experienced failures?

(check correct box)

☐ never

☐ seldom

☐ often

12. Did you use irrigation to improve pasture carrying capacity?

☐ No, if "No" go to question 13.

☐ Yes, if yes complet. (a) to (e) below

(a) How many acres of pasture land were irrigated? _____ acres

(b) Kind of pastures irrigated?
(check correct box)

☐ tame pasture

☐ native pasture

(c) Type of irrigation used
(check correct box)

☐ flood

☐ sprinkler

☐ other _____
please specify

(d) What were the development costs per acre to prepare this pasture for irrigation? (Please include land levelling, ditching, borders, syphon tubes, plastic dams and other irrigation equipment such as sprinkler systems, gated pipe, pump engines, and wells) \$ _____ per acre

(e) What are the annual operating costs per acre of irrigated pasture?
(Include cost of water, hired labor and fertilizer)

\$ _____ per acre

Please do not fill
in this column

13. Do you apply fertilizer to pastures?

- ☐ No, if "No" go to question 14.
- ☐ Yes, if yes complete (a) to (c) below

(a) How often is fertilizer applied?
(check correct box)

- ☐ semi-annually
- ☐ annually
- ☐ every 2 years
- ☐ every 3 years
- ☐ other _____
please specify

(b) How many acres of pasture did you fertilize in 1965? _____ acres

(c) On the pasture you fertilized in 1965 what type of fertilizer did you use and how many pounds did you apply per acre, on the average acre of pasture?

Formula of fertilizer
(i.e. 11-48-0 or 33.5-0-0,
or 16-20-0)

Pounds per acre

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Did you use Barnyard manure? No ☐ Yes ☐ if "yes"
_____ tons per acre

14. Considering the effects of all the pasture improvement you have carried out on your farm during the past three (3) years by how much have the improvement practices increased grazing capacity per acre?

- (a) ☐ one quarter
- ☐ one half
- ☐ three quarters
- ☐ doubled carrying capacity
- ☐ other _____
please specify

Please do not fill
in this column

(b) After improvement was the
increase in the number of
head the pasture could
carry:

(check correct box)

(☐ greater than)

(☐ equal to)

(☐ less than)

what you expected?

15. Do you consider the pasture improvements you carried out to have
been a profitable investment? No ☐ Yes ☐

16. What in your opinion is the one most profitable pasture improvement
practice for your farm?

17. What do you regard as your most serious pasture problem?

18. Please rate your three chief sources of information concerning pasture
improvement practices costs and returns (Number the most important as 1
second most important as 2 and the third most important as 3.)

☐ Neighbor

☐ Government Research Station

☐ Farm Magazines

☐ District Agriculturist

☐ Another farmer who improved his pasture

☐ Other _____

please specify

19. How much were the total sales from all farm production on your place
in 1964? (check correct box)

☐ greater than \$50,000

☐ \$40,000 - \$49,999

☐ \$30,000 - \$39,999

☐ \$20,000 - \$29,999

☐ \$10,000 - \$19,999

☐ less than \$10,000

Please do not fill
in this column

20. What portion of your total farm sales in 1964 came from sales of cattle, sheep and horses and livestock products.

(check correct box)

- ☐ all
- ☐ three-quarters
- ☐ half
- ☐ quarter
- ☐ none

--

APPENDIX G

LITERATURE REVIEW

Australian Research on Pasture Improvement

Pasture Improvement and Net Farm Income

Australian researchers have produced a notable amount of work on pasture improvement. Studies of the agronomic aspects include information concerning the productivity of grass and legume varieties, fertilizer trials, reseeding experiments, land clearing, and pasture establishment practices.

Economic analysis has kept pace with the physical research. A number of reports noted the potential for improvement and the effects that pasture improvement may have on farms. The studies generally pointed out the increased carrying capacity and particularly the improved net incomes resulting from pasture improvement. Gruen's study of wheat-sheep farms reported increases in carrying capacity of 100 - 200 percent and resulting increases in net farm income of £1650 or 80 - 100 percent.¹ Calculations were based on costs and returns of a fully improved 900 acre farm as compared to a similar farm with no pasture improvement.

Warning and Muir studied the influence of improved pasture in offsetting the cost price squeeze.² They found that improved pasture resulted in a higher net return (or lower percentage decline in net income).

¹ F. H. Gruen, "Financial Aspects of Pasture Improvement on Southern Wheat-Sheep Farms," Review of Marketing and Agricultural Economics, XXIV (December, 1956), 196-221.

² E. J. Warning and D. A. Muir, "Two Case Studies of Pasture Improvement in a Cost Price Squeeze," Review of Marketing and Agricultural Economics, XXIX (March, 1961), 5-19.

They also observed increasing returns to scale in pasture improvement. As a result, they recommended that a pasture improvement program be rapidly pursued to some critical level rather than being approached in a piecemeal fashion.

In a study of New England grazing properties James found that those with one quarter or more of their total acreage in seeded pasture showed the highest rates of return as compared to any other subgrouping classified by property size, by sheep numbers, by type of enterprise, and by type of sheep enterprise.¹ The rate of return on capital invested, even for the superior group, was only 3.4 percent.

The Long Term Nature of Pasture Improvement

Although the profitability of pasture improvement was generally recognized, it was pointed out that positive net returns were only realized after a number of years. Gruen reported that a five year development period was required before the returns from improved pasture exceeded the costs associated with the improvement.² The costs of a reseeding program on a 900 acre farm would not be fully recovered for a period of eight to twelve years. Gruen estimated the long run returns from pasture improvement to be in the range of 14-22 percent.

Pearse reported that three to eight years would be required to repay a pasture improvement loan, assuming that none of the increased returns were used to improve the operator's standard of living.³

¹ B. J. F. James, "Report on an Economic Survey of New England Grazing Properties," Review of Marketing and Agricultural Economics, XXIX (December, 1961), 161-183.

² Gruen, Op. cit.

³ R. S. Pearse, "Financial Returns and Capital Requirements for Optimum Pasture Improvement Plans," Review of Marketing and Agricultural Economics XXXI (December, 1963), 178-208.

Campbell and Shand in a study of pasture improvement on seven farms estimated that returns from investment in pasture improvement ranged from 14 to 60 percent, but this estimate was based upon incomplete data.¹ Of the seven farms studied over 10 to 17 year periods, only one had recovered its initial investment; that farm had done so within a six year period. The writers suggested, however, that since substantial amounts of capital were available to these farms the incentive to recover the funds as rapidly as was possible may have reduced. They also pointed out the large initial investment required and the absence of positive returns for some period of time. Furthermore, the returns were still subject to wide fluctuations and did not always remain positive.

In cases where the risk of failure was not excessive, it appeared advisable to carry out a substantial amount of pasture improvement in a short period of time. This would produce a large deficit but would also result in rapid increase in income. If the improvements were effected continually over a number of years, a long period of deficits must be incurred before the additional returns begin to exceed the costs of improvement.

Determinants of the Rate of Improvement

Parish and Dillon noted the rapid rate of improvement which accompanied high wool prices.² When prices were high in the early 1950's, improvements of all types were readily undertaken. When prices fell in

¹ K. O. Campbell and R. Shand, "An Economic Study of Pasture Improvement on Some Farms in New South Wales," Dept. of Agricultural Economics, Mimeographed Report, No. 2, University of Sydney, (Sydney: by Authors, 1958).

² R. Parish and J. L. Dillon, "Pasture Improvement in the Southwest Slope," Review of Marketing and Agricultural Economics, XXIV (June, 1956), 51-73.

1954-55, improvement plans were reduced by one third in the first year. Molnar found that despite low levels of debt, few farmers were unwilling to borrow to improve pasture.¹ Tax concessions for pasture improvement, on the other hand, seemed to be met by positive response.

Another factor found to influence the progress of pasture improvement was the often extensive reorganization of farming operations which resulted from improvement programs. There was a definite shift toward more intensive farming methods often involving new enterprises, and certainly requiring more labour, management, and capital. Such radical renovations may not be viewed favorably by many managers.

The Application of Linear Programming Techniques to Pasture Improvement Research

Pearse's study of optimal pasture improvement programs is an excellent example of the use of linear programming to determine efficient resource use.² His study, using parametric linear programming, also illustrates some of the additional information that can be secured after the solution has been obtained.

Pearse outlined four possible methods of improving pasture. One method was the prepared seed bed technique in which grasses and legumes were seeded into a fallowed seed bed and allowed to remain for some months before grazing was commenced. A second method was combining, which was the seeding of a pasture mixture directly into the sod of an existing pasture. Grazing was continued as usual. Combined pasture later roughly cultivated

¹ I. Molnar, "Factors Influencing Recent Farm Improvements," Review of Marketing and Agricultural Economics, XXVII (March, 1959), 51-73.

³ Pearse, Op, cit.

and resown was a third practice. The final technique he cited was the application of fertilizer and clover seed to existing pastureland by means of aircraft. A somewhat similar practice but using ground broadcasting was considered but eliminated from the final problem since it was unlikely to enter the solution. All four of the methods of pasture improvement appeared in the solution at some level of capital availability or time period.

The capital requirements associated with the improvement programs included the cost of establishing the pasture, except for fixed costs such as would be associated with cultivation equipment and labor, supplies of which were considered adequate to carry on the program. Capital was also required to finance extra stock, to extend yards and buildings, to build additional fences and watering facilities, to maintain the pasture, to run the extra stock and to meet interest payments on borrowed funds.

Land formed another restraint. The problem assumed the improvements to be taken on a 1000 acre property all of which was unimproved pasture. Restrictions were placed on the amount of land that could be improved by any method in a given year.

The objective function which was maximized was net income over a 20 year period following the initiation of the improvement program. Net incomes here refer to returns minus variable costs. Returns were not discounted since it was found that discounting, while adding considerably to the effort, failed to change the ratios of the returns by more than four percent and thus failed to change the solution.

In this problem the amount of capital available annually for pasture improvement was initiated at the zero level and allowed to increase

to £1525 per annum, with a wool price of five shillings per pound. There were 45 cases with different restraints or activities operative. At low levels of investment, 12 or more years were required before the program became self-financing. At high investment rates as few as eight years were needed. At a rate of saving of £586 the improvement program became self-financing in 14 years, and the land would have been fully improved after 10 years. If the annual investment rate was £200 per annum (the maximum likely if financed from savings alone) only one third of the property would have been improved within 10 years. Investing at £1350 per year the property would be fully improved after eight years, and the program would become self-financing in the 10th year.

The rate of return on invested capital varied between 9.5% and 12.9% depending upon the level of investment (Table 1).

Evidently capital was subject to increasing returns as larger amounts were invested within the range investigated. This implied that the benefits of a rapid rate of investment which produced large increases in income relatively soon exceed the handicap of a large initial deficit. In other words, it appeared profitable to carry out the improvements as rapidly as possible.

Generally, the level of various activities was influenced little by minor changes in the capital available. However, in certain regions of capital availability small changes in the annual investment produced sweeping variations in the activities in the solution and levels at which they were employed. The problem was simplified by reducing the number of possible plans to four with an error of approximation less than one percent, which was greater accuracy than might be expected of the coefficients.

TABLE 47

RATE OF RETURN ON CAPITAL INVESTMENT ON PASTURE IMPROVEMENT (AUSTRALIA)

Annual Investment (£)	Rate of Return (%)
586	9.5
1016	12.1
1525	12.9

Source: Review of Marketing and Agricultural Economics, XXXI (December, 1963).

The marginal value products of the limiting resources were calculated for the different plans. These included the value of capital in many years, the value of land in some plans, and the sowing restraints in a few years. The values appeared quite high because they were not discounted and were only expressed as the sum of returns over twenty years. Their chief advantage was that they gave an insight into the timing of expenditures and the relaxation of the rules governing the acreages to be sown. This would be useful information in practice, for unforeseen circumstances often result in a farmer's wishing to modify his program.

The program was also run using a wool price of four shillings per pound. This solution was simplified to six possible plans. The lower price reduced the average rate of return from 10 percent, at the five shilling price, to eight percent. Also the period which elapsed until the program became self-financing was extended, making pasture improvement under these circumstances considerably more risky.

When pasture improvement is viewed in terms of the long period of high investment, substantial debt, considerable risk and long periods before increased returns improve family living levels, it is understandable that many are reluctant to pursue improvement programs. On the other hand, it may be the only hope for many Australian graziers.

Relevant Studies on this Continent

It would appear that the study of pastureland and pasture improvement in North America is not on a par with that being done in Australia. In view of the fact that their agricultural economy utilizes forage heavily, this observation may not be unreasonable or unexpected.

Experiments and trials concerning various improvement practices have been reported extensively, but not all have been subject to critical analysis. This is particularly true of the popular publications. This may be all that is required of many farmers and ranchers since they view these as sufficiently sophisticated for their purposes. Such publications do serve an essential purpose, but yet they cannot replace scientific investigation.

A study by Olsen, Heady, and Scholl is a good example of an early scientific investigation.¹ The study was basically a budgeting analysis of five different pasture improvement techniques requiring varying amounts of capital and periods of development, and yielding various levels of production. Although the cost figures and the exact methods used are out of date and not applicable to this area, there are some general results worth

¹ E. O. Heady, R. O. Olson, and J. M. Scholl, Economic Efficiency in Pasture Production and Improvement in Southern Iowa, Agricultural Experimental Station Research Bulletin 419, Iowa State College, (Ames: By authors, 1954).

outlining. Long term improvements lasting twenty years proved to be the least costly over time despite their high initial costs. The variation of the average annual costs was markedly reduced when discounting was applied. If the discounting rate was sufficiently high (20 percent), the least cost improvement method changed. Also discounting of net returns at various levels caused variations in the technique yielding maximum returns.

The found that stocking rates were usually established at what the farmer thought the pasture would carry in the poorer months of poorer or average years. This implied that pastures were usually understocked.

Two years later this data was used as part of a linear programming study of the role of pasture improvement in optimum resource allocation on farms.¹ Possible alternative activities included four cropping programs, four methods of pasture improvement, three types of beef feeding enterprises, two hog farrowing operations, a laying flock and the possibility of renting out unimproved pasture. The program was built on the basis of a 160 acre farm with 110 acres in crop and 38 in unimproved pasture. Generally a quantity of family labor was assumed, but the assumption of an unlimited labor supply was used in some cases. Capital was available at various levels between \$1000 and \$16,000.

The results gave priority to the hog operations while labor was plentiful. If labor was limiting and capital ample, beef feeding and

¹ D. E. McKee, E. O. Heady, J. M. Scholl, "Optimum Allocation of Resources Between Pasture Improvement and Other Opportunities on Southern Iowa Farms," Agricultural Exper. Station Research Bulletin 435, Iowa State College, (Ames: By authors, 1958).

pasture improvement entered the solution. Beef feeding and pasture were included only at low capital levels if the hog enterprises were restricted. The cow calf operation failed to enter in any solution. These results might very well apply to many areas of Alberta.

It will be helpful to outline one further example of a linear programming study. This particular one is not associated with pasture improvement, but the basic principle will be used in this study of pasture improvement in the province. The model is that incorporated by Heady and Egbert in their study of regional adjustments in grain production.¹ This basic model was also used by others in variations of this same study.

The Heady and Egbert model broke the United States into 144 supply regions which accounted for 95 percent of the wheat, feed grains, soybean and cotton crops. A total of 31 demand regions were demarcated. Transportation activities allowed the movement of commodities. Wheat could also be shifted from food to feed use. They sought to minimize the cost of producing and transporting the production required to meet the demand. The results of five models with varying assumptions indicated the regional adjustment that would be required of agricultural resources and the surplus capacity available.

About this time there also appeared a number of other inter-regional models which considered various facets of agricultural products

¹ E. O. Heady, and A. C. Egbert, "Programming Regional Adjustments in Grain Production to Eliminate Surplus," Journal of Farm Economics, XLI (November 1, 1959) p. 718.

including such items as eggs¹, milk^{2,3}, beef cattle⁴, and the livestock-feed economy⁵ in general. These studies are interesting from the standpoint that they provide an illustration of the capabilities of the programming technique as well as an insight to the use of such methods to simulate a portion of the economy.

Canadian Studies of Pasture Improvement

Canadian studies pertaining to pasture improvement are virtually nonexistent. The most relevant work published was "The Demand for Beef in 1980 and Related Land Requirements" which was adequately reviewed in the Introduction.⁶

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- ¹ G. G. Judge, Competitive Position of the Connecticut Poultry Industry, A Spatial Equilibrium Model for Eggs, Bulletin 318, Starrs Agricultural Experimental Station, University of Connecticut.
 - ² C. E. French and E. W. Kehrberg, "The Midwest-Eastern Seaboard Conflict of Interest in the Production and Distribution of Milk, Comparative Advantage Aspects," Journal of Farm Economics, XLII (1960), 1297.
 - ³ M. M. Snodgrass and C. E. French, "Linear Programming Approach to Interregional Competition in Dairying," Bulletin 637, Purdue University, Agricultural Experimental Station, Lafayette, Indiana, 1958.
 - ⁴ J. G. McNeely, "Interregional Competition in Livestock, Interregional Competition in Beef Cattle," Journal of Farm Economics, XXXIV (December, 1952).
 - ⁵ K. A. Fox and R. C. Taeuber, "A Spatial Equilibrium Model of the Livestock-Feed Economy of the United States," American Economic Review, ILV (September, 1955), 584.
 - ⁶ L. E. Drayton et al, "The Demand for Beef in 1980 and Related Land Requirements," Economic Annalist, XXXIV (August, 1964).

Other studies have investigated phases of beef cattle production in western Canada. The foremost study of this nature is the 1946 publication by Vrooman, Chattaway, and Stewart.¹ Other studies, less extensive but more current, have appeared since then. Burkell investigated southern Saskatchewan cattle ranches and recent changes in cattle production.^{2,3} Darcovich studied resource productivity in three beef producing areas of Alberta.^{4,5} The complete analysis of cattle ranches in the shortgrass and foothills region that is currently being prepared by Elgaard is keenly awaited by many researchers interested in cattle production.⁶ Askin found that many farms in the Camrose areas of Alberta could profitably make use of cattle operations, particularly to utilize low value land.⁷

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- ¹ C. W. Vrooman, G. D. Chattaway and A. Stewart, Cattle Ranching in Western Canada, Canada Department of Agriculture, Publication No. 778, (Ottawa: 1946).
 - ² S. R. Burkell, "Organization and Management Practices of Cattle Ranchers in Southern Saskatchewan," Economic Annalist, XXVI (April, 1956)
 - ³ S. R. Burkell, "Recent Changes in Cattle Production in Alberta and Saskatchewan," Economic Annalist, XXVIII (February, 1958).
 - ⁴ W. Darcovich, "Farm Organization and Resource Productivity in Some Beef Producing Areas of Alberta," Economic Annalist, XXVII (December, 1957).
 - ⁵ W. Darcovich, "The Use of Production Functions in the Study of Resource Productivity in Some Beef Producing Areas of Alberta," Economic Annalist, XXVII (August, 1958).
 - ⁶ K. Elgaard, "Who Makes Money in the Ranch Business," Canadian Cattlemen, XXVIII (April, 1965).
 - ⁷ T. Askin, "The Cattle Enterprise in Relation to Farm Organization in Alberta," Economic Annalist, XXI (December, 1951).

Whereas the studies cited all investigate important areas of beef cattle production and provide interesting and important information none deal directly with the question of pasture improvement or the possibility of developing new pastureland. The need for reliable and direct data bearing on pasture utilization and potential in Alberta and Canada is indeed very pressing.

BIBLIOGRAPHY

1. Alberta Department of Agriculture. Farm Machinery Rates, Alberta. Publication 325. Edmonton.
2. Alberta Department of Agriculture and Department of Lands and Forests. Range, Its Nature and Use. Publication 146, Extension Branch and Lands Branch, Edmonton.
3. Alberta Soils Advisory Committee. Soils and Fertilizer Test Results in Alberta, 1949-1960. Confidential Report, Department of Soil Science. Edmonton: University of Alberta.
4. Askin, T. "The Cattle Enterprise in Relation to Farm Organization in Alberta," Economic Annalist, XXI, (December, 1951), 133-136.
5. Boulding, K. E. and W. A. Spivery. Linear Programming and the Theory of the Firm. New York: MacMillan Co., 1960.
6. Bratvold. O. G., Hay and Pasture Crops for Alberta. Publication 63, Alberta Department of Agriculture, Fields Crops Branch, Edmonton, 1965.
7. Burkell, S. R., "Organization and Management Practices of Cattle Ranchers in Southwestern Saskatchewan." Economic Annalist, XXVI (April, 1956), 110-115.
8. Burkell, S. R., "Recent Changes in Cattle Production in Alberta and Saskatchewan." Economic Annalist, XXVIII (February, 1958) 19-23.
9. Calder, F. W. and F. S. Warren, Pasture Renovation in the Maritime Provinces. Publication 1024, Canada Department of Agriculture, Research Branch. Ottawa, 1958.
10. Campbell et al, Range Management of Grasslands and Adjacent Parklands in the Prairie Provinces. Publication 1133, Canada Department of Agriculture, Research Branch, Ottawa, 1962.
11. Campbell, K. O. and R. Shand, An Economic Study of Pasture Improvement on Some Farms in New South Wales. Mimeographed Report No. 2, Department of Agricultural Economics, University of Sydney, 1958.
12. Canada Department of Agriculture. Costs of Production in Agriculture. Economics Branch, Ottawa, 1965.
13. Canada Department of Agriculture. Experimental Farm, Manyberries, Alberta, Progress Report, 1954-58. Experimental Farm Services, Ottawa.
14. Canada Department of Agriculture. General Information on Agriculture in Canada. Economics Branch, Ottawa, 1965.

15. Clark, S. E., J. A. Campbell and J. B. Campbell, An Ecological and Grazing Capacity Study of the Native Grass Pasture in Southern Alberta, Saskatchewan and Manitoba. Publication 738, Canada Department of Agriculture, Ottawa, 1942.
16. Clark, S. E. and D. H. Heinrichs, Regrassing Abandoned Farms, Submarginal Cultivated Lands and Depleted Pastures in the Prairie Areas of Western Canada. Publication 720, Dominion Experimental Station, Swift Current, Saskatchewan, 1941.
17. Dantzig, G. B., Linear Programming and Extension. Princeton: Princeton University Press, 1963.
18. "Demand for Beef in 1980 and Related Land Requirements," Economic Annalist, XXIV (August, 1964), 77-85.
19. Dillon, W. J., A Summary of Hay Production Costs. Publication 60, Ontario Department of Agriculture, Farm Economics and Statistics Branch, Toronto.
20. Darcovich, W., "Farm Organization and Resource Productivity in Some Beef Productivity Areas of Alberta," Economic Annalist, XXVII (December, 1957) 125-132.
21. Darcovich, W., "The Use of Production Functions in the Study of Resource Productivity in Some Beef Producing Areas of Alberta," Economic Annalist, XXVIII (August, 1958), 85-93.
22. Dorfman, R., P. A. Samuelson and R. M. Solow. Linear Programming and Economic Analysis. New York: McGraw-Hill Book Co., 1958.
23. Drayton, L. E., "Red Meat Consumption in Canada," Economic Annalist, XXIV (October, 1959), 101-108.
24. Egbert, A. C. and E. O. Heady, Regional Adjustments in Grain Production, A Linear Programming Analysis. Technical Bulletin 1241, U.S. Department of Agriculture, Washington, D. C., 1961.
25. Elgaard, K., "Address to the Western Stockgrowers Association Annual Convention, Medicine Hat, Alberta, 1965." Canada Department of Agriculture, Economics Branch, Edmonton, 1965.
26. Elgaard, K., "Who Makes Money in the Ranch Business," Canadian Cattlemen, XXVIII (April, 1965), 18-21.
27. Fox, K. A. and R. C. Faeuber, "A Spatial Equilibrium Model of the Livestock-Feed Economy of the United States," American Economic Review, XLV (September, 1955), 584-608.

28. French, C. E. and E. W. Kehsberg, "The Midwest-Eastern Seaboard Conflict of Interest in the Production and Distribution of Milk, Comparative Advantage Aspects," Journal of Farm Economics, XLII (December, 1960) 1297-1310.
29. Friesen, H. A. et al, Brush Control in Western Canada. Publication 1240, Canada Department of Agriculture, Ottawa, 1965.
30. Garvin, W. W., Introduction to Linear Programming. New York: McGraw-Hill Book Co., 1960.
31. Gruen, F. H., "Financial Aspects of Pasture Improvement in Southern Wheat-Sheep Farms," Review of Marketing and Agricultural Economics, XXIV (December, 1956) 196-221.
32. Hackett, B. A., "Economics of Beef Cow-Calf Production," Alberta Department of Agriculture, Farm Economics Branch, 1965 (Mimeographed).
33. Haythorne, D. F. and K. Elgaard, Alberta Cattle Feeding Study. Canada Department of Agriculture, Economics Branch, Edmonton, 1965.
34. Heady, E. O. "Simplified Presentation and Logical Aspects of Linear Programming Technique," Journal of Farm Economics, XXXVI (December, 1954) 1035-48.
35. Heady, E. O. and W. Candler, Linear Programming Methods. Ames: Iowa State University Press, 1958.
36. Heady, E. O. and A. C. Egbert, "Programming Regional Adjustments in Grain Production to Eliminate Surpluses," Journal of Farm Economics XLI (November, 1959), 718-733.
37. Heady, E. O., R. O. Olson and J. M. Scholl. "Economic Efficiency in Pasture Production and Improvement in Southern Iowa." Research Bulletin 419, Agricultural Experimental Station, Iowa State College, 1954.
38. Heady, E. O. and M. Skold, "Projection of U.S. Agricultural Capacity and Interregional Adjustments in Production and Land Use with Spatial Programming Models." Preliminary Production Economics 33, Department of Economics and Sociology, Iowa State University.
39. Heady, E. O. and L. G. Tweeten, Resource Demand and Structure of the Agricultural Industry. Ames: Iowa State University Press, 1963.
40. Heady, E. O. and N. K. Whittlesey., "A Programming Analysis of Inter-regional Competition and Surplus Capacity of American Agriculture." Research Bulletin 538, Agricultural and Home Economics Experimental Station, Iowa State University, 1965.

41. International Business Machines Corporation. An Introduction to Linear Programming. Technical Publications Department, White Plains, New York, 1964.
42. James, B. J. F., "Report on an Economic Survey of New England Grazing Properties," Review of Marketing and Agricultural Economics, XXIX (December, 1961) 161-183.
43. Johnson, Alex et al, Alberta Guide to Range Sites, Condition Classes and Recommended Stocking Rates. Canada Agricultural Research Station, Lethbridge and Alberta Department of Lands and Forests, Edmonton, (Mimeographed).
44. Jones, A. R. and L. Bauer., Farm Business Report, Irrigation District. Alberta Department of Agriculture, Farm Economics Branch, Edmonton, 1964.
45. Judge, G. G., "Competitive Position of the Connecticut Poultry Industry, A Spatial Equilibrium Model for Eggs." Bulletin 318, Agricultural Experimental Station, University of Connecticut, Storrs.
46. Kansas State University. "Kansas Farm Management Association Account Book." Extension Division, Manhattan, 1965.
47. Kantorovich, L. V., "Mathematical Models in the Organization and Planning of Production." Publication House of the Leningrad State University, 1939. Translated in Management Science, VI, (July, 1960), 366-422.
48. Looman, J., "The Potential for Pasture Development in the Parkland and Sub-Boreal Forests Area of the Prairie Provinces," Canada Department of Agriculture, Experimental Farm, Swift Current, Saskatchewan: (Mimeographed).
49. Love, H. C., "Income Variation in Beef Production." Agricultural Economics Research Bulletin 1, Department of Extension, University of Alberta, Edmonton, 1966.
50. MacKenzie, J. D., "Resource Requirements for the Production of Beef Calves and Yearlings in the Peace River Area of Alberta." Agricultural Economics Special Report 2, University of Alberta, Edmonton, 1966.
51. McIver, R. N. and E. V. McCurdy. The Improvement of Burn-Out Lands in South Central Saskatchewan. Publication 600, Canada Department of Agriculture, Ottawa, 1955.
52. McKee, D. E., E. O. Heady, and J. M. Scholl, "Optimum Allocation of Resources Between Pasture Improvement and Other Opportunities on Southern Iowa Farms." Research Bulletin 435, Agricultural Experimental Station, Iowa State College, 1956.

53. McLean, A., W. Pringle, and T. G. Willis, Reseeding Grassland Ranges in the Interior of British Columbia. Publication 1108, Canada Department of Agriculture, Research Branch, Ottawa, 1961.
54. McNeely, J. G., "Interregional Competition in Livestock, Interregional Competition in Beef Cattle," Journal of Farm Economics, XXXIV (December, 1952), 897-900.
55. Molnar, I., "Factors Influencing Recent Farm Improvements," Review of Marketing and Agricultural Economics, XXVII (March, 1959), 51-73.
56. National Research Council. Feed Composition. Publication 659, Washington, D. C. National Research Council, 1959.
57. National Research Council. Nutrient Requirements for Beef Cattle. Publication 1137, Washington, D. C. National Research Council, 1963.
58. Nesius, E. J., "Allocation of Farm Resources for Economic Production of Pasture Forage," Bulletin 568, Kentucky Agricultural Experimental Station, University of Kentucky, Lexington, 1951.
59. Parish, R. and J. L. Dillon, "Pasture Improvement in the Southwest Slops," Review of Marketing and Agricultural Economics, XXIV (June, 1956), 51-73.
60. Pearce, R. A., "Financial Returns and Capital Requirements for Optimum Pasture Improvement Plans," Review of Marketing and Agricultural Economics, XXXI (December, 1963), 171-208.
61. Snodgrass, M. M. And E. C. French, "Linear Programming Approach to Interregional Competition in Dairying." Bulletin 637, Purdue University Agricultural Experimental Station, Lafayette, Indiana, 1958.
62. Stockton, R. S., Introduction to Linear Programming. Boston: Allyn and Bacon Inc., 1960.
63. Thomsen, G., Pasture Costs of Private Pastures in Saskatchewan. Economics and Statistics Branch, Saskatchewan Department of Agriculture, Regina, 1965.
64. United States Department of Agriculture. Costs and Returns on Commercial Farms, Long Term Study, 1954-63. Statistical Bulletin 368, Economic Research Service, Washington, D. C., 1966.
65. University of Alberta. "Feeders' Day Reports." Department of Animal Science, Edmonton, 1960-66.
66. Vajda, S., Readings in Linear Programming. New York: John Wiley and Sons, Inc., 1958.

67. Van Arsdall, R. N., "Resource Requirements, Investments, Costs and Expected Returns From Selected Beef-Feeding and Beef Raising Enterprises." Agricultural Experimental Station, University of Illinois, Urbana, 1965.
68. Vrooman, C. W., G. D. Chattaway and A. Stewart. Cattle Ranching in Western Canada. Publication 778, Canada Department of Agriculture, Ottawa, 1946.
69. Warning, E. J. and J. Jackson, "Property Development in New England," Review of Marketing and Agricultural Economics, XXXI (September, 1963) 151-164.
70. Warning, E. J. and D. A. Muir, "Two Case Studies of Pasture Improvement in a Cost Price Squeeze," Review of Marketing and Agricultural Economics, XXXIX (March, 1961), 5-19.
71. Wilson, D. B. and R. D. Clark, "Irrigated Pastures in Southern Alberta." Publication 1160, Canada Department of Agriculture, Agricultural Research Station, Lethbridge, Alberta, 1964.
72. Woolam, G. E., The Influence of Price on the Relative Consumption of Beef and Pork. Economics Division, Canada Department of Agriculture, 1953.

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